MDOT

MICHIGAN DEPARTMENT OF TRANSPORTATION

State Long-Range Transportation Plan 2005-2030

Highway/Bridge Technical Report

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MI Transportation
MICHIGAN LONG RANGE TRANSPORTATION PLAN

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List of Acronyms

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway Transportation Officials
ATMS	Advanced Traffic Management Systems
AVMT	Annual Vehicle Miles of Travel
BCFS	Bridge Condition Forecast System
BMS	Bridge Management System
CCTV	Closed Circuit Television
CFR	Code of Federal Regulations
CoRe	Commonly Recognized
CPL	Carpool Parking Lot
CPM	Capital Preventive Maintenance
CSM	Capital Scheduled Maintenance
CVMT	Commercial Vehicle Miles Traveled
DI	Distress Index
DMS	Dynamic Message Signs
FCP	Freeway Courtesy Patrol
FHWA	Federal Highway Administration
FO	Functionally Obsolete
FOT	Field Operational Tests
GIS	Geographic Information System
HBP	Highway Bridge Program
HPMS	Highway Performance Monitoring System
I/E	Improve and Expand
IRI	International Roughness Index
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITS	Intelligent Transportation Systems
JPCP	Jointed Plain Concrete Pavement
LOS	Level of Service
LTPP	Long-Term Pavement Performance Study

MDOT	Michigan Department of Transportation
MDNR	Michigan Department of Natural Resources
MEDC	Michigan Economic Development Corporation
MSP/MCD	Michigan State Police, Motor Carrier Division
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NFC	National Functional Classification
NHS	National Highway System
OBE	On Board Equipment
PASER	Pavement Surface Evaluation and Rating
PSC	Public Sector Consultants
PTR	Permanent Traffic Recorders
ROW	Right-of-Way
RQFS	Road Quality Forecasting System
RSE	Roadside Equipment
RSL	Remaining Service Life
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SD	Structurally Deficient
SEMCOG	Southeast Michigan Council of Governments
SHRP	Strategic Highway Research Project
STC	Michigan State Transportation Commission
STP	Surface Transportation Program
TEA-21	Transportation Equity Act for the 21st Century
TWIS	Truck Weight Information System
USDOT	United States Department of Transportation
V2I	Vehicle to Infrastructure
V2V	Vehicle-to-Vehicle
VII	Vehicle Infrastructure Initiative
VMT	Vehicle Miles Traveled
WIM	Weigh-in-Motion

Executive Summary

Purpose:

The objective of the *Highway & Bridge Technical Report* is to provide an overview of Michigan's trunkline roadway system. In Michigan, there are three separate types of government agencies (over 600 individual agencies) which have responsibility for the state's roadways:

- State of Michigan over state trunkline highways;
- 83 County Road Commissions over county roads; and
- 533 incorporated cities and villages over municipal streets.

This report focuses on the state trunkline highways managed by the Michigan Department of Transportation (MDOT). It is very important to know that trunkline highways are not just road pavement and bridges. They also include non-pavement infrastructure such as signs, pavement marking, guardrails, signals, safety, drainage structures, weigh stations, non-motorized facilities, lighting, pump houses, etc. They are an integral part of the system MDOT manages. This *Highway & Bridge Technical Report* presents information on the inventory of system assets, system condition, system performance, as well as issues and considerations that may impact MDOT's ability to meet customer needs and to meet and sustain its current system condition goals.

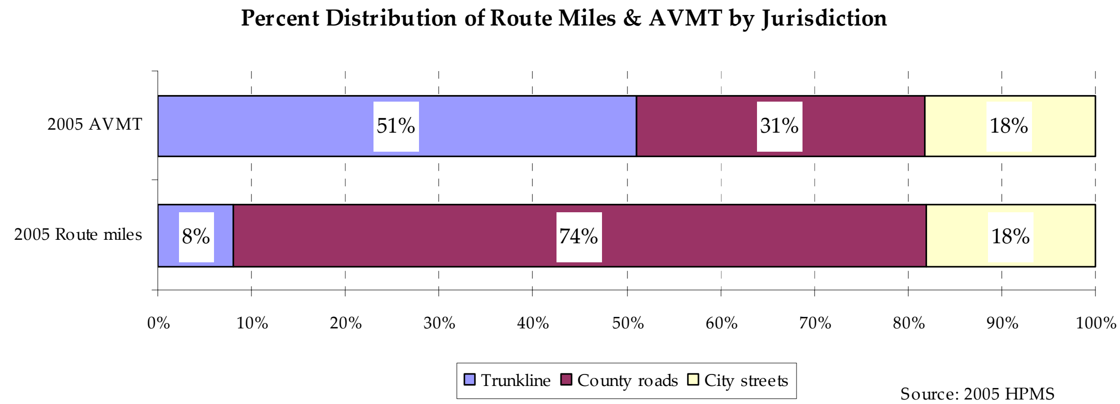
Public Act 51 defines asset management as "an ongoing process of maintaining, upgrading, and operating physical assets cost-effectively, based on a continuous physical inventory and condition assessment" [MCL 247.659a (1) (a)]. MDOT follows this asset management approach to manage its transportation system assets and to enhance decision-making for transportation asset improvement.

Highlights of MDOT transportation assets are summarized in the following sections:

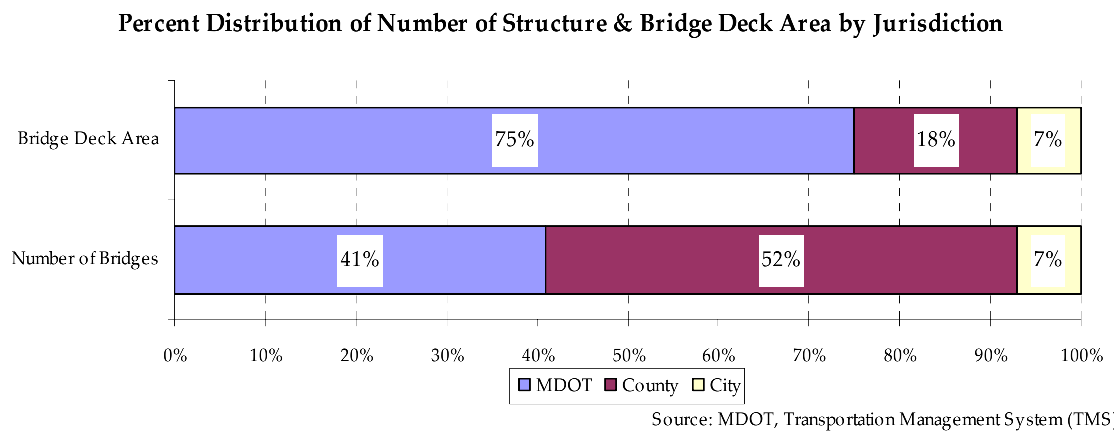
Trunkline System Inventory:

a. MDOT has jurisdictional responsibility for approximately 9,700 route miles of state trunkline highways, which consist of all the "I", "M", and "US" numbered highways, and 4,413 bridges.

b. Michigan's system of state trunkline highways, county roads, and city streets totals 119,570 miles. The state trunkline system, managed by MDOT, comprises 8 percent (9,695 miles) of Michigan's roadway network and carries 51 percent of total statewide traffic. County roads and city streets together consist of 92 percent (109,875 miles) of Michigan's roadway system but they only carry half of the statewide traffic.



c. MDOT has jurisdictional responsibility for approximately 4,413 trunkline bridges having over 49 million square feet of bridge deck area. Nearly 1,700 (approximately 40 percent of total trunkline bridges) of MDOT's bridges are on major freeways (I-75, I-94, I-96 or I-69). MDOT bridges are much larger and carry more traffic than local jurisdiction bridges. Although MDOT is responsible for 41 percent of the state bridges, this accounts for 75 percent of the bridge deck area of all Michigan's highway bridges.



d. Highway non-pavement infrastructure addressed in this technical report includes signs, pavement marking, guardrails, signals, safety, drainage structures, weigh stations, non-motorized facilities, lighting, pump houses, carpool parking lots, rest areas, and Type II noise abatement barriers. Some definitive data are briefly summarized:

- There are more than 200 carpool parking lots (CPLs) spread across the state. In 2005, the official CPLs accommodated 2,852 users; this is a 13-percent increase of usage from 2004.
- Eighty-five rest areas in the state serve approximately 50 million visitors annually, with 44 percent of the rest areas serving 500,000 or more visitors annually.
- MDOT provided infrastructure for 21 weigh sites, which are operated by the Michigan State Police, Motor Carrier Division (MSP/MCD). In the late 1990s,

agreements were executed with MSP/MCD to deemphasize traditional weigh station operations at interior weigh stations and shift enforcement to more mobile patrols.

- There are 2,550 miles of non-freeway roadways with paved shoulders of four feet or more, which may potentially support non-motorized use.
- Currently, there are 30 Type II noise abatement barriers located along MDOT's trunkline system. They are found predominantly in southern Michigan, primarily in five counties (Wayne, Washtenaw, Macomb, Oakland, and Kalamazoo).

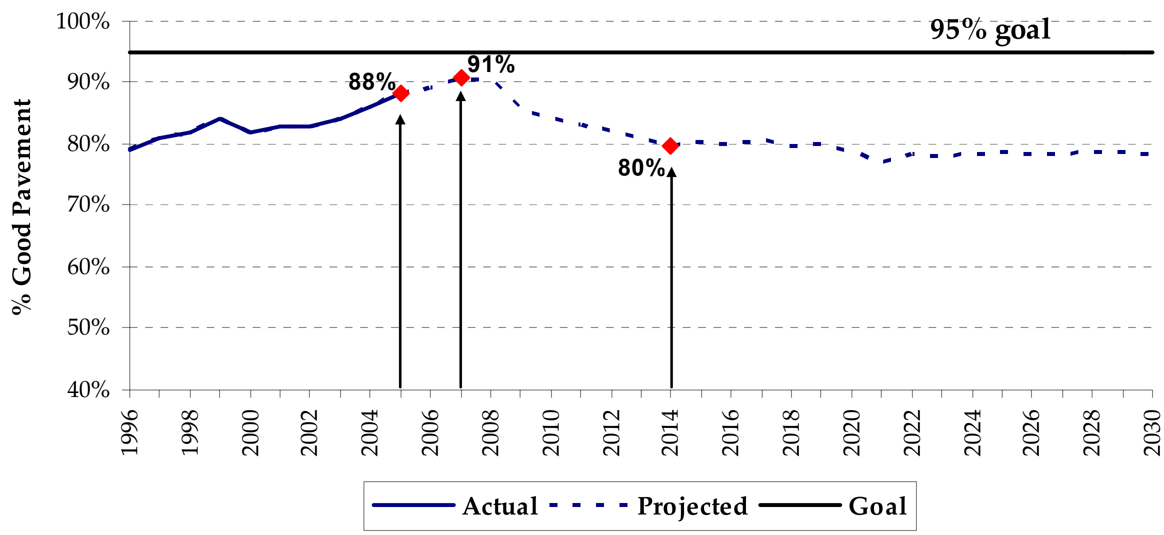
Trunkline System Condition:

The overall condition of the system can be displayed in terms of pavement, bridge, and non-pavement infrastructure condition. It is generally projected that conditions will deteriorate over the next 10 years if today's funding levels continue.

a. **Pavement Condition Goal:** MDOT's goal of having 95 percent of pavement in "good" condition on the freeway system and 85 percent on the non-freeway system by 2007 has led to significant improvements in recent years.

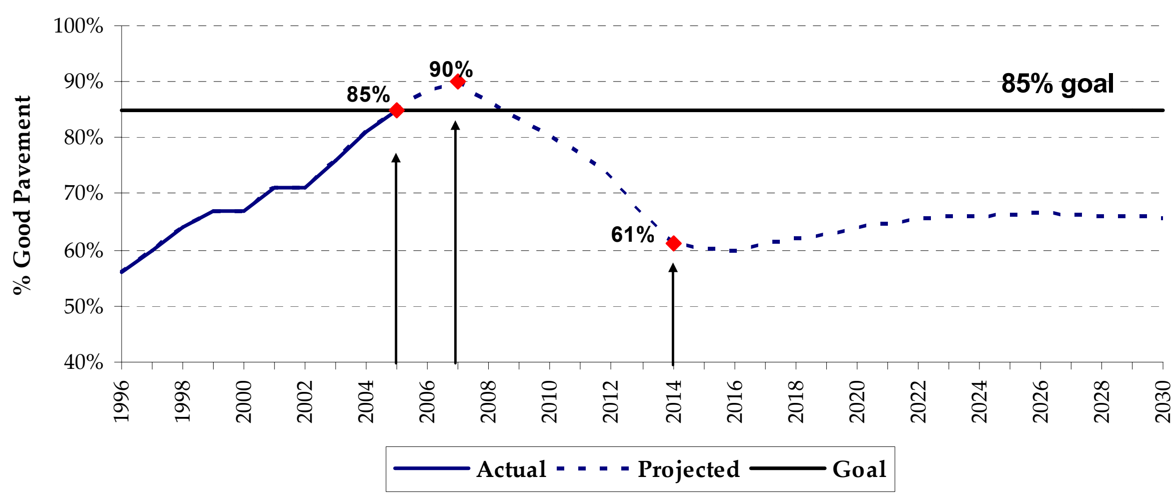
    - Overall pavement conditions on the statewide trunkline system have steadily improved in the last 10 years, from 64 percent good in 1996 to 86 percent good in 2005. At this time, MDOT has reached the non-freeway goal of 85 percent good (two years early)! On the freeway network, the system has steadily improved to reach a condition of 88 percent good, while MDOT continues to work toward achieving the goal of improving the network to 95 percent good by 2007.
    - With the help of additional resources through bonding, such as the *Preserve First* and *Jobs Today* programs, the near-term outlook for the state's freeway pavements is projected to improve until it reaches a level of 91 percent good in 2007, but falling short of the freeway goal of 95 percent. Over the long term, MDOT projects that freeway pavement conditions will begin to decline until they reach approximately 80 percent good in 2014, and remain at that level to 2030. Similarly, the non-freeway pavement condition has benefited from the bonding programs and will continue improving, even exceeding the 85 percent goal in 2007. Like the freeway, it is expected to begin declining until reaching approximately 60 percent good in 2014 where it will remain under 70 percent through 2030.

Statewide Trunkline System (Freeway Only)
Long Term Pavement Condition Trend



Source: Michigan Department of Transportation, Road Quality Forecasting System

Statewide Trunkline System (Non-Freeway Only)
Long Term Pavement Condition Trend

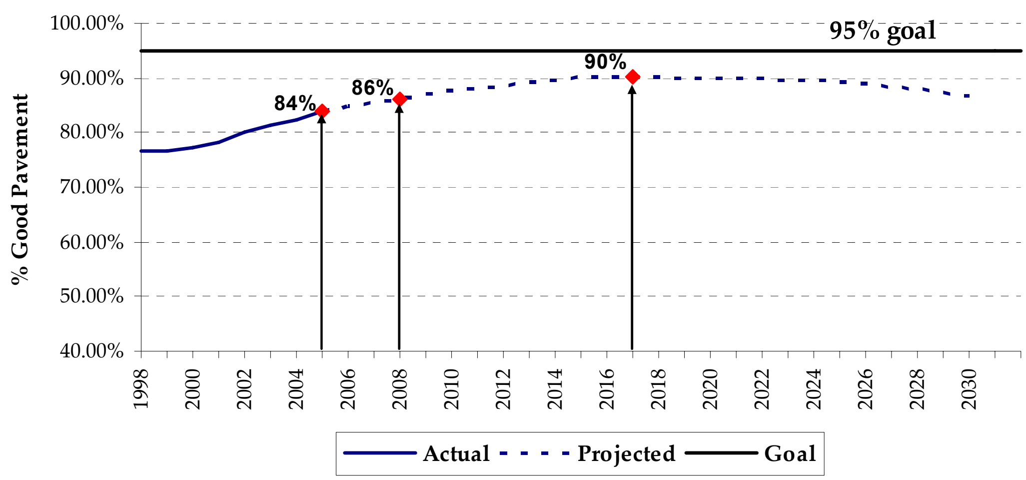


Source: Michigan Department of Transportation, Road Quality Forecasting System

b. **Bridge Condition Goal:** MDOT's goal of having 95 percent of bridges in good condition on the freeway system and 85 percent on the non-freeway system by 2008 has led to steady improvements in recent years.

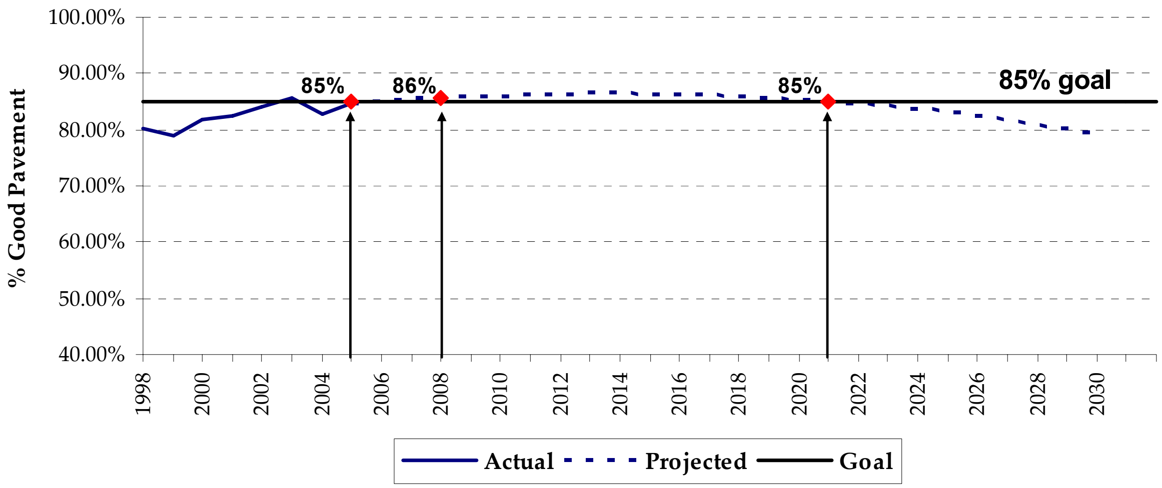
- Overall conditions on the statewide trunkline bridges have progressively improved since 1998, from 78 percent good in 1998 to 84 percent good in 2005. At this time, the bridge condition is approaching the level of 85 percent good on the non-freeway network and 84 percent good on the freeway network; MDOT continues to work toward achieving the bridge goals by 2008.
- At existing funding levels, the outlook for the state's freeway bridge condition is not expected to meet its goal to have 95 percent of freeway bridges in good or "fair" condition by 2008. Freeway bridge condition will peak at approximately 90 percent good or fair in 2017, after which the condition will start to decline. In 2003, MDOT achieved the non-freeway bridge goal of 85 percent in good or fair condition. Current funding levels are expected to support maintaining the non-freeway condition state of 85 percent good to the year 2021, after which inflation is expected to outpace current funding levels, and bridge conditions will decline to less than 85 percent good or fair.

Statewide Trunkline System (Freeway Only)
Long Term Bridge Condition Trend



Source: Michigan Department of Transportation, Bridge Condition Forecast System

Statewide Trunkline System (Non-Freeway Only)
Long Term Bridge Condition Trend



Source: Michigan Department of Transportation, Bridge Condition Forecast System

c. **Non-Pavement Infrastructure Condition:**

- The pavement condition of the CPLs show that 85 percent are in good condition and 96 percent are in good to fair condition, with an average Pavement Surface Evaluation and Rating (PASER) rating of 7.2 out of 10.
- Currently 37 rest areas have 500,000 or more visitors each year, with only 60 percent of those being of the current design and considered in good condition at the end of 2005.

Trunkline System Performance:

Highway and bridge performance is considered with respect to mobility, connectivity, importance of non-pavement infrastructure, and deployment of special technology:

a. Congestion affects the mobility performance of Michigan's roadways. For urban freeways, 15 percent (6 % of the statewide total) of the vehicle miles traveled (VMT) is congested and 40 percent (17 % of the statewide total) of the VMT is approaching congested conditions. While for urban non-freeway trunkline, 20 percent (4 % of the statewide total) of the VMT is congested and 23 percent (5 % of the statewide total) of the VMT is approaching congested conditions.

   At current funding levels (with the currently planned projects), 43 percent (18 % of the statewide total) of urban freeway VMT will be congested and 29 percent (12 % of the statewide VMT) of the VMT will be approaching congested conditions. While 39 percent (8 % of the statewide total) of the urban non-freeway trunkline VMT will be congested and 23 percent (5 % of the statewide total) of the VMT will be approaching congested conditions by 2030.

b. Connectivity to different types of activities and facilities is related to both the geographic location of the activities throughout the state, and the available highway drive times. It is measured by the percentage of the population, households and employment that is within a 15-minute highway journey to each activity type. Connectivity is the greatest challenge for port facilities, air carriers, and intermodal freight facilities, which are located at specific locations in the state, usually more than a 15-minute drive from most places of housing and employment. More than half of Michigan's population and employment are at locations with a drive time of more than 45 miles from intermodal freight facilities. For freight facilities, connectivity to particular industry sectors in freight-intensive activity centers is more important than for other types of employment centers. The *Corridors and Borders Report* of *MI Transportation Plan* further explores the connectivity of different types of trade centers to corridors and intermodal facilities.

c. Special technology deployment areas of special interest include Intelligent Transportation Systems (ITS), the Vehicle Infrastructure Initiative (VII), Permanent Traffic Recorders (PTR), and Weigh-in-Motion (WIM) detectors.

   VII is an emerging ITS initiative aimed at creating linkages between intelligent vehicles and infrastructure systems. Multiple technologies have been tested in Michigan under this program and will be incorporated with complementary initiatives in other states for inclusion in the national formal Field Operational Tests (FOT) proposed by the US Department of Transportation (USDOT).

   Michigan's 135 PTRs provide an automated and efficient way of measuring traffic conditions. Since these devices came into use in the 1930s, technology has enhanced their capabilities, with newer recorders providing data about speed and vehicle types.

   WIM sensors can detect the weight of large trucks without requiring the truck to leave the highway and enter a weigh station. These sensors are used both in weight enforcement for commercial trucks, and for pavement design at high-truck locations.

Issues and Challenges:

Special issues and considerations for highway and bridge planning in *MI Transportation Plan* include:

a. At current funding levels, pavement deterioration and congestion are both expected to worsen in the long term; increased funding is needed to preserve the system condition. Resources for roadway improvements will also be needed to support overall performance through highway investments.

b. Identify important attributes of the roadway system from a user's perspective. To that end, a study entitled *The Driver Perceptions of Roadway Characteristics* was conducted, which involved an analysis of user insights on important characteristics for Michigan's roadways. The findings of the study indicated that pavement condition, safety, and smoothness on roadways were ranked as the most important roadway characteristics for everyday users. Visibility and traffic flow were also found important to users, with appearance and cleanliness ranking least in importance among the attributes studied.

c. Michigan has tested European design pavements, which are thicker and use different construction techniques than typical Michigan pavements. European designs are more than twice as expensive as typical pavements. The results are not yet conclusive enough to support a decision about whether designs should be changed in this plan.

Bridge issues include:

a. The Federal Highway Administration's (FHWA) current bridge sufficiency ratings place less emphasis on the condition of bridge decks, overlooking important safety and preservation issues on Michigan's bridges.

b. The bridge sufficiency formula affects the funding available for Michigan's bridges and creates a challenge for improving bridges with decks in need of improvement.

c. Because bridge under-clearance standards have changed since many of Michigan's bridges were constructed, the expense of bridge rehabilitation and replacement projects must take into account today's standards. This contributes to the increased financial need for bridge improvements.

d. Scour critical bridges are bridges that may be compromised by rapidly flowing water during flood events. Michigan has over 400 bridges identified as scour critical bridges. Retrofitting or replacing these bridges for potential flood and high-water events contributes significantly to the cost of Michigan's overall highway needs.

Special issues on non-pavement infrastructure include:

a. CPLs face issues such as enforcement, clarification of legal definitions of carpool lots, a need for a five-year template for funding the commercial parking lot program, and legal changes enabling MDOT to operate the lighting of these lots.

b. The Roadside Development program supports Michigan's rest areas. The program faces issues such as the spacing, property acquisition, accommodating commercial vehicles and the aesthetic quality of these facilities. When rest areas are added or improved, the Roadside Maintenance Program also has issues associated with maintaining these facilities to prevent new needs from emerging.

c. There are other non-pavement infrastructure issues pertaining to non-motorized assets, drainage structures, weigh stations, Type II noise abatement barriers, lighting, and pump houses.

   MDOT has the potential to leverage roadway improvements by incorporating non-motorized facilities into the design and construction of new facilities or in major reconstruction projects. Better tracking of the development and maintenance needs of non-motorized facilities may also help to preserve these assets. Bicycle and pedestrian counts are ways to assess the use and need for bicycle and pedestrian facilities. Public Act 82 provides MDOT greater potential to leverage roadway improvement projects to improve non-motorized safety and access by including sidewalks.

MDOT currently has no comprehensive way of tracking the condition of drainage structures. Because these are evaluated at the individual project level, there are potential drainage structure needs that may not be captured in the current plan.

With an average cost of five million dollars to build, weigh stations are very expensive assets. Efficiency may be gained by further utilizing WIM technology and "virtual weigh stations."

The most recent State Transportation Commission Noise Abatement Policy (2003) contains no provision for addressing noise abatement barrier preservation and maintenance. The policy will have to be revisited to address preservation and maintenance needs of existing noise barriers.

Conclusion:

The highway and bridge system supports the same users and activities as many other components of Michigan's integrated transportation system. Key user segments of the highway and bridge system are identified as travelers driving alone or using high occupancy vehicles, using transit, riding in school buses, cycling, walking, or using snowmobile crossings on Michigan's roadways. Commercial trucking firms are also a critically important user segment. Economic activities supported by the system are robust and include virtually all types of activities in the state. Pavement deterioration, congestion, crashes, and a lack of connectivity to activities and other modes are all potential performance barriers for the highway and bridge system. These barriers threaten the performance of not only highways and bridges, but also other components of the system that depend on safe, sustainable, and reliable roadway connections. The special technology initiatives described in the report are suggested as opportunities to support safe and sustainable access to Michigan's economic activities.

Chapter 1. Introduction

1.1 Report Objectives

This *Highway & Bridge Technical Report* is provided in support of *MI Transportation Plan*. Reports supporting the plan provide reference material and information about users of Michigan's transportation system and ways in which the different components of the system seek to meet overall user requirements. The findings of this report are integrated with the findings of other reports (the *Integration Technical Report*, the *Corridors and Borders Report*, the *Conditions and Performance Technical Report* and the *Gap and Investment Analysis*) to understand Michigan's transportation system including highway, transit, non-motorized, intercity, freight, and other infrastructure and service components of the system.

The objective of this *Highway & Bridge Technical Report* is to provide an overview of the Michigan state trunkline system. The report will discuss MDOT's asset management philosophy for managing our trunkline system (routes designated as "I," "US," and "M") and provide information about historical, current, and future issues and activities related to managing that system. The latest inventory of trunkline assets will be presented by freeway and non-freeway network.

Information regarding MDOT's current pavement and bridge conditions, as well as forecasted future conditions, will be discussed and displayed in some detail. Included are summaries explaining how and why MDOT established condition goals, descriptions about the tools that were used to establish them, and how those tools are used to monitor progress. The report will discuss some of what MDOT has learned and what MDOT expects for the future.

The report will also include information on non-pavement infrastructure, such as carpool parking lots, rest areas, drainage, weigh stations, non-motorized facilities, and Type II noise abatement barrier programs. This report will also provide explanations and descriptions regarding mobility performance (level of service), connectivity to trade centers and intermodal facilities, as well as information regarding deployment of special technologies for MDOT's system. The last section of the report will provide information on issues and considerations that may impact MDOT's ability to meet customer needs and meet and sustain MDOT's current pavement and bridge condition goals.

1.2 Asset Management Approach

MDOT follows an asset management approach to managing its transportation system assets. Public Act 51 defines asset management as "an ongoing process of maintaining, upgrading, and operating physical assets cost-effectively, based on a continuous physical inventory and condition assessment." [MCL 247.659a (1) (a)]

Asset management provides a solid foundation, which allows transportation professionals to monitor the transportation system. The asset management approach enhances transportation asset improvement decisions by optimizing the preservation, improvement, and timely replacement of assets through cost-effective management, programming and resource allocation decisions.[1]

Asset management involves collecting physical inventory and managing current conditions based on strategic goals and sound investments. It is a continuous process enabling managers to evaluate various scenarios, determine trade-offs between different actions, and select the best method for achieving specified goals.

While asset management utilizes the outputs of pavement and bridge management systems (BMS), discussed later in this document, it is much more than just another management system with a fancy name. The significant difference is that, in many respects, pavement and BMSs are used in a tactical manner to identify specific projects. Asset management is a strategic approach that looks at the network as whole rather than individual projects.

Traditionally, public sector management of roads and bridges has been tactical in nature, concentrating on the immediate and most severe problems. Asset management shifts that thinking to one that is strategic in nature, identifying an optimal "mix of fixes" approach. Decisions are made with regard to the long-range condition of the entire system. This requires consideration of various investment strategies, which will maintain the assets in good condition. This mix of fixes approach involves the integration of short-term, medium-term, and long-term fixes to cost-effectively manage pavement, bridge, and other state trunkline facilities.

1.2.1 Short, Medium, and Long-Term Fixes

Short-term fixes are low-cost improvements implemented on facilities in good condition and are designed to retard future deterioration and improve functional conditions, extending the time until major improvements will be needed. Examples of pavement preventive maintenance work include: crack treatments, micro-surfacing, thin bituminous overlays, or full depth concrete repairs. Examples of preventive maintenance on bridges include: deck patching, deck joint replacement, or partial (zone) painting of bridge beam ends.

Medium-term fixes are considered when preventive maintenance is no longer a cost-effective treatment, but reconstruction is not yet needed or cost-effective. Medium-term fix types involve resurfacing and/or rehabilitating existing pavements or bridge facilities. Examples of medium-term fixes on pavement surfaces include: removing the top layer of an existing surface, making some structural repairs to the underlying surface, and adding a new pavement surface. Examples of medium-term fixes on bridges include: superstructure and substructure repairs, such as deep or shallow concrete deck overlays, standard deck overlays, patching concrete beams, steel repairs, pin and hanger replacements, or (full) bridge painting.

Long-term fixes are the most costly improvements and involve reconstruction of pavement or bridge facilities. The work for pavements involves removing an entire pavement section,

[1] Asset Management Primer, USDOT/FHWA, Office of Asset Management, December 1999.

removing and restoring of the sub-base, and replacing the surface. For bridges, the work involves removing the deck or bridge structure, and/or the superstructure and replacing what is removed to current standards.

1.2.2 Strategic Focus of Asset Management

It is crucial in an asset management process to have the ability to forecast future road and bridge conditions and to do investment analyses based on various funding scenarios. The strategic component of the decision-making process entails the ability to assess improvements based on desired outcomes. The strategic focus of an asset management process is supported by network level analysis in addition to the tactical focus of performing location-specific, project-level analysis. This task would include consideration of:

- Current condition of the transportation system and future condition if there is no change in current practices;
- Future condition based on alternative strategies;
- The right time to maintain, preserve, or improve to get maximum useful life from a transportation asset;
- Use preventive fixes or allow an asset to deteriorate to the point of requiring reconstruction;
- Costs and benefits of each decision; and
- Relationship to identified goals and objectives.

The key is the conscious effort required to create and analyze alternatives. It is necessary to focus attention on effectively and efficiently managing and operating our transportation system, rather than merely reconstructing the system. The major elements of an asset management system are summarized as follows:

- Establishing goals and objectives through development of a strategic plan;
- Collecting data to measure progress toward achieving the established goals and objectives;
- Using management systems to control the various processes;
- Developing appropriate performance measures;
- Identifying standards and benchmarks;
- Developing alternative analyses procedures;
- Making decisions based on these results and developing an appropriate program;
- Implementing the program; and
- Monitoring and reporting results of actions taken.

Chapter 2. Inventory

2.1 Inventory Overview

This inventory section will provide a snapshot of highway roads, bridges, and non-pavement assets of Michigan's current transportation system. While MDOT only has direct jurisdiction over Michigan's trunkline system, the department does provide funding to other government agencies that have transportation assets under their own jurisdiction. The inventory overview is arranged by highway road, highway bridge, and highway non-pavement categories to provide available inventory data specific to each category.

2.2 Highway Road Inventory

2.2.1 Mileage

In Michigan, [2]there are three separate government agencies, which have responsibility over the state's roadways:

- State of Michigan (MDOT) over state trunkline highways;
- 83 County Road Commissions over county roads; and
- 533 incorporated cities and villages over municipal streets.

The Michigan Department of Transportation (MDOT) has jurisdictional responsibility for approximately 9,700 route miles of state trunkline highways, which consist of all the "I," "US," and "M" numbered highways. The state's 83 county road commissions are responsible for about 89,000 miles of county roads and cities and villages are responsible for approximately 21,000 miles of municipal streets. There are various ways to account for roadway mileages. **Table 1** summarizes different roadway miles by government agencies. The definition of roadway mileages, route miles, pavement miles, and lane miles, are also noted at the bottom of the table.

Table 1: Michigan Roadway Mileage by Jurisdiction

	Route Miles	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
State Trunkline	9,695.1	8.1%	12,055.3	9.9%	27,557.4	11.0%
County Roads	88,960.3	74.4%	89,113.4	72.9%	180,040.7	71.6%
City/Village Streets	20,914.1	17.5%	21,012.0	17.2%	43,745.5	17.4%
Total	119,569.5	100.0%	122,180.7	100.0%	251,343.6	100.0%

Source: 2005 Highway Performance Monitoring System

Note: Route Miles: Route miles include all undivided mileage, the forward side mileage of divided roadways, and both directions of one-way pairs (separate streets carrying each direction of traffic).

[2] Source: *Act 51 Primer* prepared by William E. Hamilton, House Fiscal Agency, May 2003

Pavement Miles: Pavement miles include undivided mileage, both side mileage of divided roadways, and both directions of one-way pairs.

Lane Miles: Lane miles include all lengths multiplied by the number of lanes.

2.2.1.1 National Functional Classification

The National Functional Classification (NFC) system was initiated by the US Congress in 1968. The NFC system defines the streets and highways into classes according to the character of service the roads are intended to provide. This allows roads to be studied and compared across different regions of the state or the entire country. NFC is also used to determine which roads are eligible to receive federal funds for improvements. If a road has an NFC of collector or higher it is eligible for federal aid, usually under the federal Surface Transportation Program (STP). Federal aid eligibility is the main reason why most road agencies are interested in NFC.

Principal arterials are at the top of the NFC hierarchical system. Principal arterials generally carry long distance, through-travel movements. They also provide access to important traffic generators, such as major airports or regional shopping centers. Examples are interstates and other freeways; other state routes between large cities; important surface streets in large cities.

Minor arterials are similar in function to principal arterials, except they carry trips of shorter distance and to lesser traffic generators. Examples are state routes between smaller cities; surface streets of medium importance in large cities; important surface streets in smaller cities.

Collectors tend to provide more access to property than do arterials. Collectors also funnel traffic from residential or rural areas to arterials. Examples are county, farm-to-market roads; various connecting streets in large and small cities.

Local roads primarily provide access to property. EXAMPLES: Residential streets; lightly-traveled county roads. **Table 2** and **Table 3** summarize different roadway miles by government agencies by NFC.

Table 2: Michigan Roadway Mileage by Jurisdiction by National Functional Classification (NFC): Trunkline System

Trunkline System	*National Functional Classification (NFC)*	*Route Miles*	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
Urban	Principal Arterial-Interstate	634.4	6.5%	1,268.9	10.5%	3,444.6	12.5%
	Principal Arterial-Other Freeways	327.8	3.4%	655.0	5.4%	1,464.9	5.3%
	Principal Aeterial-Others	1,115.6	11.5%	1,421.5	11.8%	4,457.3	16.2%
	Minor Arterial	516.7	5.3%	538.1	4.5%	1,344.0	4.9%
	Collector	9.4	0.1%	10.6	0.1%	21.1	0.1%
	Local	2.9	0.0%	2.9	0.0%	5.7	0.0%
Rural	Principal Arterial-Interstate	608.7	6.3%	1,217.4	10.1%	2,589.9	9.4%
	Principal Aeterial-Others	2,584.4	26.7%	3,011.8	25.0%	6,236.6	22.6%
	Minor Arterial	3,430.5	35.4%	3,463.9	28.7%	7,047.9	25.6%
	Major Collector	454.0	4.7%	454.7	3.8%	924.0	3.4%
	Minor Collector	0.5	0.0%	0.5	0.0%	0.9	0.0%
	Local	10.2	0.1%	10.2	0.1%	20.4	0.1%
Statewide Trunkline		9,695.1	100.0%	12,055.3	100.0%	27,557.4	100.0%

Source: 2005 Highway Performance Monitoring System (HPMS)

Table 3: Michigan Roadway Mileage by Jurisdiction by National Functional Classification (NFC): County Roads and City/Village Streets

County Roads	*National Functional Classification (NFC)*	*Route Miles*	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
Urban	Principal Arterial-Interstate	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Principal Arterial-Other Freeways	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Principal Aeterial-Others	766.9	0.9%	860.7	1.0%	2,730.6	1.5%
	Minor Arterial	2,513.7	2.8%	2,568.4	2.9%	5,873.9	3.3%
	Collector	1,743.9	2.0%	1,747.9	2.0%	3,529.2	2.0%
	Local	9,786.7	11.0%	9,786.7	11.0%	19,544.5	10.9%
Rural	Principal Arterial-Interstate	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Principal Aeterial-Others	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Minor Arterial	1,387.9	1.6%	1,388.4	1.6%	2,827.0	1.6%
	Major Collector	15,457.5	17.4%	15,457.6	17.3%	30,930.2	17.2%
	Minor Collector	4,736.5	5.3%	4,736.5	5.3%	9,473.1	5.3%
	Local	52,567.2	59.1%	52,567.2	59.0%	105,132.2	58.4%
County Roads Total		88,960.3	100.0%	89,113.4	100.0%	180,040.7	100.0%

City/Village Streets	*National Functional Classification (NFC)*	*Route Miles*	*% of Total*	*Pavement Miles*	*% of Total*	*Lane Miles*	*% of Total*
Urban	Principal Arterial-Interstate	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Principal Arterial-Other Freeways	0.3	0.0%	0.3	0.0%	0.6	0.0%
	Principal Aeterial-Others	425.7	2.0%	449.1	2.1%	1,585.8	3.6%
	Minor Arterial	1,686.9	8.1%	1,742.7	8.3%	4,485.9	10.3%
	Collector	1,733.3	8.3%	1,751.6	8.3%	3,728.6	8.5%
	Local	14,159.3	67.7%	14,159.3	67.4%	28,116.7	64.3%
Rural	Principal Arterial-Interstate	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Principal Aeterial-Others	0.0	0.0%	0.0	0.0%	0.0	0.0%
	Minor Arterial	34.7	0.2%	34.7	0.2%	73.6	0.2%
	Major Collector	371.4	1.8%	371.9	1.8%	750.8	1.7%
	Minor Collector	55.4	0.3%	55.4	0.3%	110.8	0.3%
	Local	2,447.2	11.7%	2,447.2	11.6%	4,892.7	11.2%
City/Village Streets Total		20,914.1	100.0%	21,012.0	100.0%	43,745.5	100.0%

Source: 2005 Highway Performance Monitoring System (HPMS)

2.2.1.2 National Highway System (NHS)

The National Highway System (NHS) was established on November 28, 1995 through the National Highway System Designation Act of 1995. The system was expanded somewhat when the Transportation Equity Act for the 21st Century (TEA-21) was adopted on June 9, 1998.

The NHS is the result of efforts by every state transportation department in the country, including cooperation with local government representatives. Their goal was to select those streets, roads, and highways having the greatest state, regional, and national significance. Various criteria were used in the selection process in order to meet the following objective.[3]

Provide an interconnected system of principal arterial routes which will serve major population centers, international border crossings, ports, airports, public transportation facilities, and other intermodal transportation facilities and other major travel destinations; meet national defense requirements; and serve interstate and interregional travel.

Federal guidelines for the selection process included a functional classification requirement. With few exceptions, the NHS was selected from among all routes classified as principal arterial. Interstate Highways (freeways), a type of principal arterial, were automatically included within the NHS. In those few cases where an NHS route was something other than a freeway or another kind of principal arterial, it was selected based on its connection to a major intermodal terminal or to a military facility.

For the entire country (and Puerto Rico), the NHS includes 162,140 total route miles, including 46,837 route miles of interstate freeways (2004 data). Among that total, Michigan's NHS contributes a total of 4,761 route miles.

The following mileage table, **Table 4**, is derived from 2004 NHS data as submitted for 2004 Highway Performance Monitoring System (HPMS). This shows that, while exceptions exist, the majority of NHS routes in Michigan are principal arterials and state trunklines.

Table 4: Michigan National Highway System (NHS) Route Miles by Jurisdiction by National Functional Classification (NFC)

Jurisdiction	*NFC Principal Arterial*	*NFC Non-Principal Arterial*	*Total Miles*
State Trunkline	4,450	0	4,450
County	206	13	219
City	85	7	92
Total Miles	4,741	20	4,761

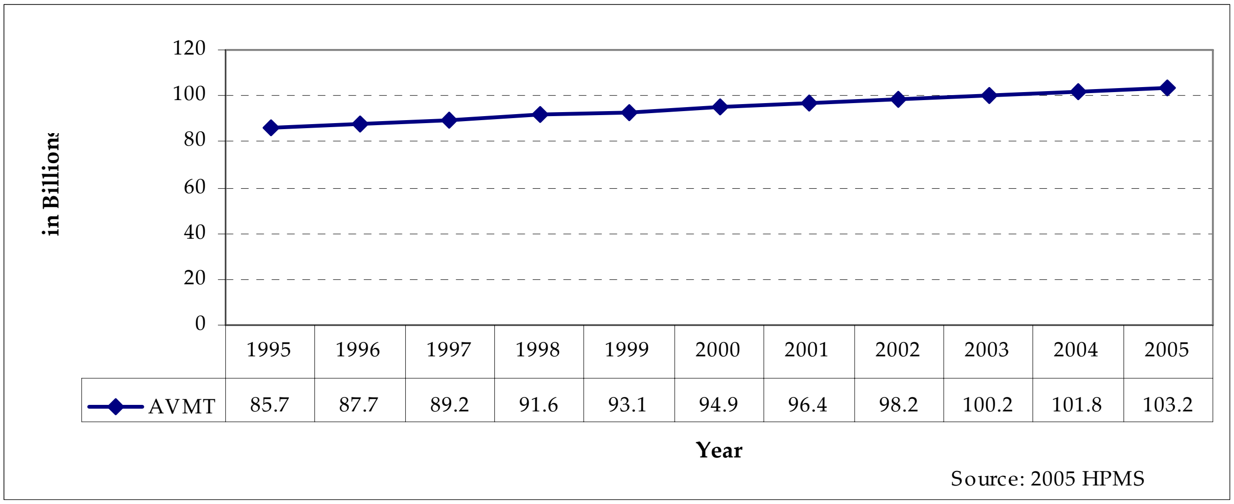
Source: Highway Performance Monitoring System 2005

2.2.2 Annual Vehicle Miles Traveled and Commercial Vehicle Miles Traveled

Michigan roadway usage on all roads reported by Annual Vehicle Miles of Travel (AVMT) rose to 103.2 billion in the year 2005. This is an almost 20 percent increase from 85.7 billion in the year of 1995. **Figure 1** indicates that the number of Vehicle Miles Traveled (VMT) on all Michigan roads increased at a stable rate during the past decade.

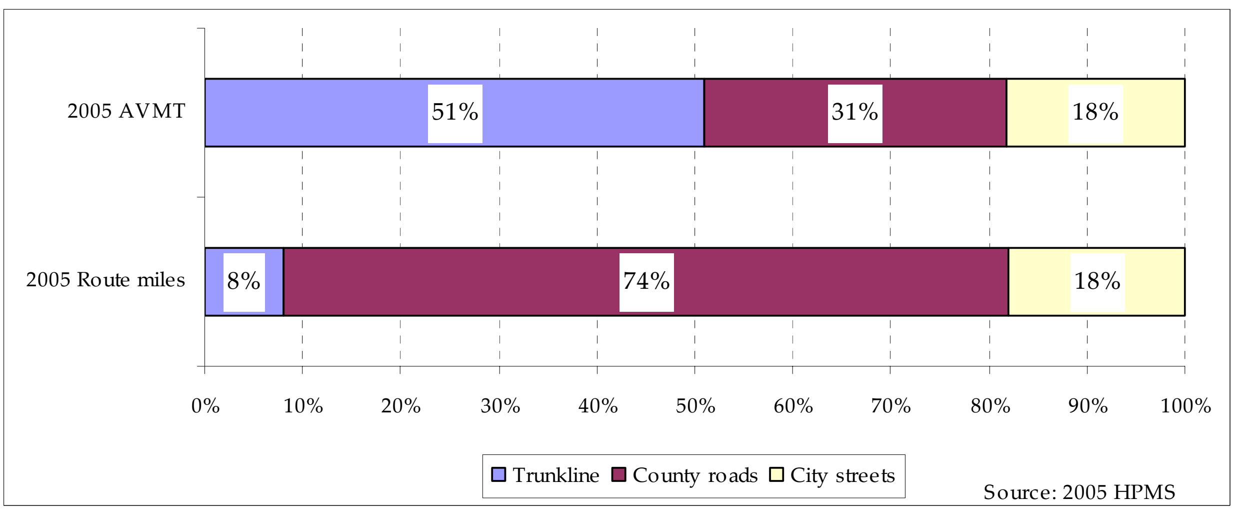
[3] Source: From the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Section 1006

Figure 1: Historical Trend of Michigan AVMT



The distribution of 2005 AVMT and route miles for Michigan roadways by jurisdiction is displayed in **Figure 2**. The state trunkline system, which is managed by MDOT, carries 51 percent of the total statewide traffic, even though it only comprises 8 percent of Michigan's roadway network.

Figure 2: Percent Distribution of AVMT and Route Miles by Jurisdiction



The following inventory data section will focus on the trunkline system and provide more detailed information about MDOT's responsibility. **Table 5** displays roadway travel (AVMT), as well as the commercial vehicle miles traveled (CVMT) on the trunkline system by network: freeway/non-freeway and urban/rural.

Table 5: Annual Vehicle Miles Traveled and Commercial Vehicle Miles Traveled on State Trunkline System

Trunkline System		*2004 Annual Vehicle Miles Traveled*		*2004 Commercial Vehicle Miles Traveled*	
		Billions of Miles	*% of state total*	*Billions of Miles*	*% of state total*
Freeway	Urban	22.61	42	2.13	43
	Rural	8.68	16	1.42	29
	Subtotal	31.29	58	3.55	72
Non-Freeway	Urban	11.87	22	0.52	11
	Rural	10.58	20	0.85	17
	Subtotal	22.45	42	1.37	28
Statewide	Urban	34.48	64	2.65	54
	Rural	19.26	36	2.27	46
	Total	53.74	100	4.92	100

Source: Transportation Management System (TMS)

The traffic volume and traffic characteristics for Michigan's state highway system are major inputs into MDOT's long-range strategies. When traffic data is combined with network level roadway facility information, the character of traffic flow (or traffic congestion) can be described by assigning segments of the system a Level of Service (LOS) using the letters A through F. The LOS for a route segment is currently determined using the methodologies presented in the *2000 Highway Capacity Manual*.[4] For the purposes of this report, **Table 6** is used to identify congested roadways. Based on this table, **Table 7** summarizes the congested and uncongested mileages by freeway/non-freeway network on MDOT's trunkline system.

Table 6: Congested Route Segment based on Level of Service (LOS)

	Freeway	*Non-Freeway*
Uncongested	LOS=A, B, C	LOS=A, B, C
Approaching Congested	LOS=D, E	LOS=D
Congested	LOS=F	LOS=E, F

[4] *Highway Capacity Manual* , HCM 2000, Transportation Research Board, National Research Council, Washington, D.C. 2000.

Table 7: Annual Vehicle Miles Traveled and Traffic Congestion

Trunkline System		*2004 Annual Vehicle Miles Traveled*		
		Billions of Miles	*% of Network*	*% of Total*
Freeway	Not Congested	27.83	89	52
	Congested	3.46	11	6
	Subtotal	31.29	100	58
Non-freeway	Not Congested	19.53	87	36
	Congested	2.92	13	6
	Subtotal	22.45	100	42
Statewide Trunkline	Not Congested	47.36		88
	Congested	6.38		11
	Total	53.74		100

Source: Transportation Management System (TMS)
*Not Congested includes Uncongested and Approaching Congestion

2.2.3 Road Pavement Condition

MDOT has several tools, using several methods, and different types of indices to describe the condition of roadways. One of the tools MDOT has been using is the Road Quality Forecasting System (RQFS) to report roadway pavement condition and expected performance. This system provides current and forecasted distributions by percentage of Michigan's trunkline system based on pavement Remaining Service Life (RSL). The network calculation of RSL and the rate at which pavements deteriorate help MDOT to manage the state's system condition over time. These calculations help MDOT maintain an efficient programming process, because predictions of future pavement deterioration help minimize pavement failure surprises.

The methodology for calculating RSL takes into consideration a historical view of roadway surface distress, using the Distress Index (DI), to project future deterioration. For pavement sections that do not have enough distress data to predict future deterioration, MDOT uses historical data observed from similar kinds of projects with commercial traffic volume information to develop estimates of RSL. With the combination of historical performance data and the judgment of trained professionals, MDOT believes that it is developing a system to help make wise asset management decisions well into the future.

Other condition indicators, such as the International Roughness Index (IRI), which measures roughness, are used and reported in The Road Information Project (TRIP) report each year.[5] The Pavement Surface Evaluation and Rating (PASER) system has been adopted by Michigan's Transportation Asset Management Council to measure Michigan's entire highway system and

[5] Texas Transportation Institute, *TRIP Report*.

is used by most of the local road agencies throughout Michigan. PASER is a visual, windshield survey to make an assessment of current pavement surface condition. The performance measure of RSL and condition measures such as IRI, DI, and PASER are all used together to help transportation professionals cost-effectively manage Michigan's trunkline highway system. The RQFS program and PASER system are further discussed in the following sections.

2.2.3.1 Road Quality Forecasting System (RQFS) and Remaining Service Life (RSL)

The key performance measure used by MDOT is called Remaining Life Service (RSL). It is defined as the estimated number of years until it is no longer cost-effective to perform preventive maintenance on, or reactively maintain, a pavement section. When a pavement section reaches a RSL of zero to two, it becomes more cost-effective to prepare rehabilitation or reconstruction work. RSL is a good performance measure for use in MDOT's forecasting software tool, RQFS, because it takes into consideration not only the current condition state, but incorporates data from previous years to predict future deterioration. Historical project and condition data are used to calculate the deterioration rate for specific segments and to determine the current RSL of each. By using several years of treatment type and distress data, MDOT is able to assess the rate of deterioration of a pavement segment.

MDOT has learned that at least three condition measurement points (collected over a six-year period) are desired to analyze deterioration in order to estimate RSL based on actual condition. When MDOT does not have enough historical condition data collected to forecast the RSL for a specific pavement section, standard RSL values are assigned based on the treatment type history and commercial ADT values for the section. The distress data used to calculate RSL are referred to as Distress Index (DI) values, which are quantified representations of pavement surface condition calculated from specific distress type/severity/extent observations. The surface is described as a distress free surface when the calculated DI is equal to zero. The surface condition is considered beyond the condition threshold for preventive maintenance work when the DI ≥ 50, therefore, suggesting that a major rehabilitation or reconstruction project should be seriously considered to improve the pavement structurally. A DI ≥ 50 would correlate to a RSL of zero.

MDOT combines pavement RSL into categories according to ranges of RSL values. For example, Category I pavements have RSL values of 0-2 years, which MDOT identifies as poor. This category of pavements is associated with MDOT's current pavement condition goals of achieving a condition state of 95 percent good for the freeway network and 85 percent good for the non-freeway network by 2007.

Table 8 illustrates the various pavement RSL category definitions that MDOT uses to manage the state trunkline network.

Table 8: Remaining Service Life Categories

Category	*RSL (Years)*	*Condition*
I	0-2	Poor
II	3-7	
III	8-12	
IV	13-17	
V	18-22	
VI	23-27	Good
VII	28-32	
VIII	33-37	
IX	38-42	

A pavement with an RSL of zero is certainly capable of being driven on. Because RSL takes into account pavement history and deterioration rates, the RSL of a given pavement may not readily correlate to what the casual observer sees on the surface. This makes RSL a difficult measure to relate to the public. MDOT is aware of this difference and is interested in knowing the correlation between MDOT's customer ratings of the pavement condition and the RSL performance measure and other ratings used. MDOT has contracted with Public Sector Consultants (PSC) to undertake a study to research the above issue. The findings of the study are discussed in **Section 5.1, Highway Pavement Issues and Related Studies**.

Even though RSL may sometimes be difficult for the public to correlate with what they see on the surface, the calculations of how fast a pavement is deteriorating and where the pavement currently is on the deterioration curve help MDOT engineering professionals in the planning of pavement improvement projects that have to begin well in advance of construction. Many major pavement improvement projects begin five years in advance of the construction dates. The RSL performance measure also helps MDOT know when preventive maintenance treatments are most beneficial and cost-effective to maximize taxpayer dollars.

The combination of using RSL with various other performance measures enables MDOT to help identify projects that will be both cost-effective and beneficial from comfort: ride oriented and safety perspectives.

2.2.3.2 Pavement Surface Evaluation and Rating PASER System[6]

The Asset Management Council uses the PASER system to rate the condition of the roads. PASER is a visual survey that rates the condition of various types of pavement distress on a scale of 1-10. The council chose PASER because it is easy to collect, is of sufficient detail for

[6] Source: *2005 Annual Report*, Michigan Transportation Asset Management Council.

statewide, network-level analyses, and is the method currently used by most road agencies in Michigan. The system that the council uses to convert the PASER ratings to help with asset management is the Roadsoft software package. Similar, to RQFS, Roadsoft converts historical PASER ratings to RSL values to help transportation agencies plan into the future.

PASER uses 10 separate ratings, with one being the worst and 10 being a newly-constructed pavement. PASER measures the distress of a pavement's surface and is a subjective method based upon sound engineering principles. Individuals must take a training course before being allowed to rate the roads.

The council groups the 10 ratings into three categories based upon the type of work required for each rating. These categories are routine maintenance, capital preventive maintenance (CPM), and structural improvements, as shown in **Table 9.**

Table 9: Type of Works Required Based on PASER Ratings

Work Category	*PASER ratings*
Routine Maintenance	8,9,10
Capital Preventive Maintenance	5,6,7
Structural Improvements	1,2,3,4

2.2.3.2.1 Routine Maintenance

Routine maintenance are the day-to-day, regularly-scheduled activities to prevent water from seeping into the surface, such as street sweeping, drainage clearing, gravel shoulder grading, and crack sealing. PASER ratings 8, 9, and 10 are included in this category. This category also includes roads that are newly-constructed or recently seal-coated. They require little or no maintenance.

2.2.3.2.2 Capital Preventive Maintenance

CPM is at the heart of asset management. It is the planned set of cost-effective treatments to an existing roadway that retards further deterioration and maintains or improves the functional condition of the system without significantly increasing the structural capacity. The purpose of CPM fixes is to protect the pavement structure, slow the rate of deterioration, and/or correct pavement surface deficiencies for a very cost-effective price. PASER ratings 5, 6, and 7 are included in this category. Roads in this category still show good structural support, but the surface is starting to deteriorate. CPM is intended to address pavement problems before the structural integrity of the pavement has been severely impacted.

2.2.3.2.3 Structural Improvements

Roads with a PASER rating of 1, 2, 3, or 4 are in need of some type of structural improvement such as resurfacing or major reconstruction. Rutting[7] (surface depression in

[7] World Wide Web site: training.ce.washington.edu

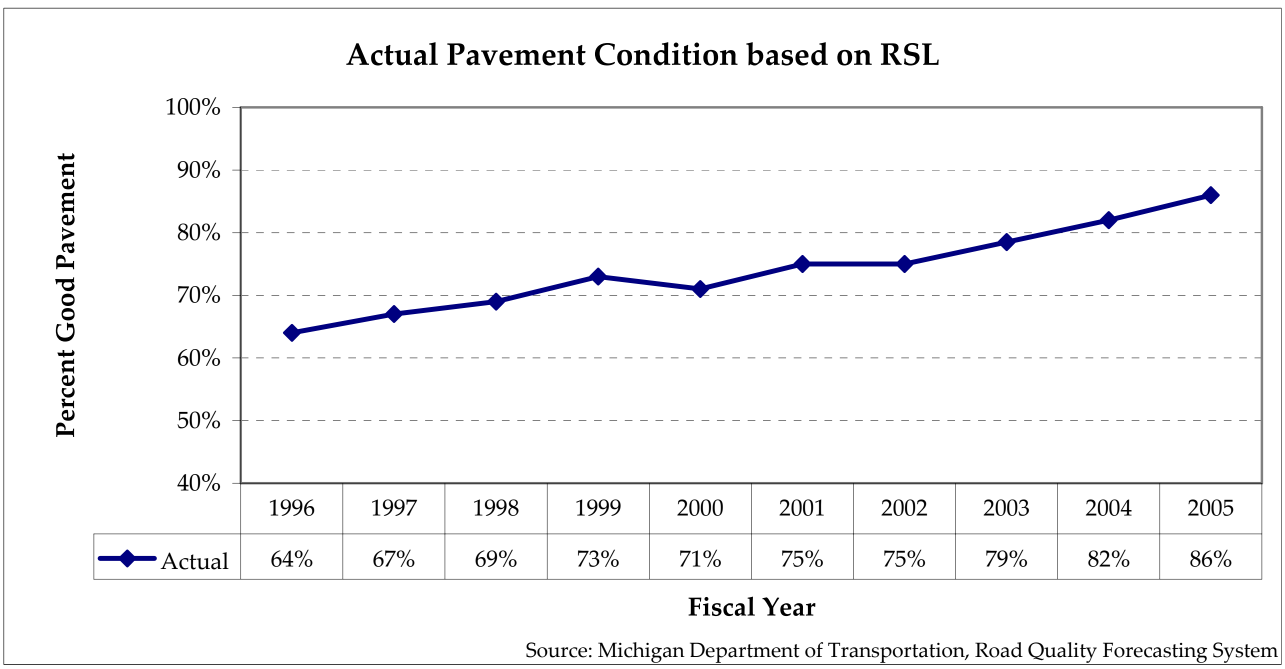
the wheel path) is beginning to take place and alligator cracking (series of interconnected cracks caused by fatigue failure) is evident.

2.2.4 Road Pavement Condition Based on RSL

MDOT has made substantial progress since the adoption of pavement condition goals in 1997. The preservation projects included in MDOT's Five-Year Program are prioritized based on approved asset management strategies, with a specific focus on reconstructing the worst roads and bridges, rehabilitating structures that still have some structural integrity, but are beyond preventive maintenance, and using cost-effective preventive maintenance treatments extending the life of roads and bridges to keep them in good condition. Our programs include a combination of long-term fixes (reconstruction), intermediate fixes (resurfacing/rehabilitation), an aggressive CPM program, and routine maintenance of the system.

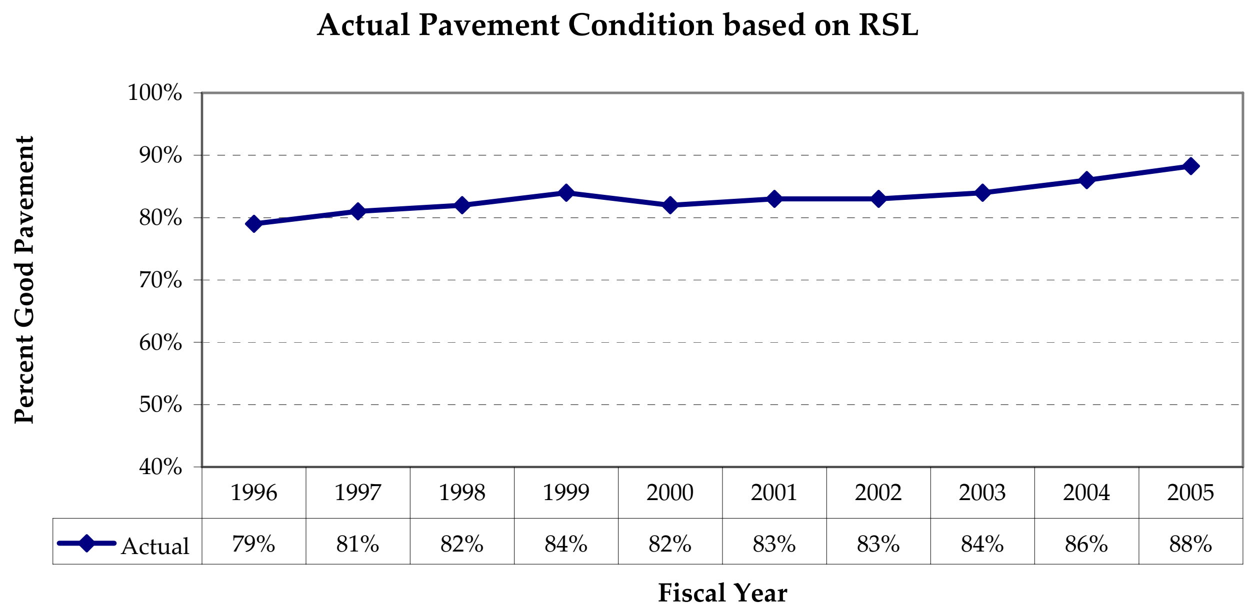
The most current RQFS report shows 86 percent of statewide trunkline pavement is in good condition after the implementation of the Fiscal Year (FY) 2005 road program, as shown in **Figure 3**. It has been a significant accomplishment to improve the state trunkline condition from 64 percent good in 1996 to 86 percent (a 22-percent increase) good in 2005.

Figure 3: Actual Pavement Condition on Statewide (Freeway & Non-Freeway) Trunkline System



As shown in **Figure 4**, MDOT has continued to make progress by increasing the percent of good pavements on the freeway network. At the end of FY 2005, 88 percent of MDOT's freeway system was in good condition.

Figure 4: Actual Pavement Condition on Trunkline Freeway System

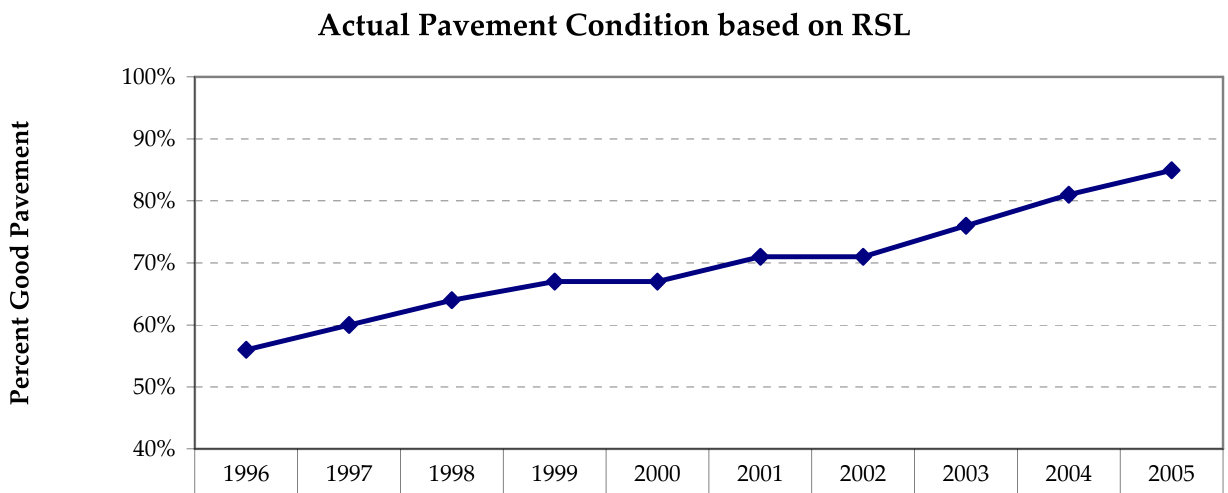


	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Actual	79%	81%	82%	84%	82%	83%	83%	84%	86%	88%

Source: Michigan Department of Transportation, Road Quality Forecasting System

Progress also continues on the non-freeway system. At the end of FY 2005, 85 percent of MDOT's non-freeway system was in good condition, as shown in **Figure 5**. This is the first year that non-freeway system reached the department's goal of 85 percent good, two years earlier than our goal year of 2007.

Figure 5: Actual Pavement Condition on Trunkline Non-Freeway System



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Actual	56%	60%	64%	67%	67%	71%	71%	76%	81%	85%

Source: Michigan Department of Transportation, Road Quality Forecasting System

2.3 Highway Bridge Inventory

2.3.1 Bridge Count

Michigan's bridges provide key links in the state's highway system, providing access to employment, schools, shopping, and medical facilities, as well as facilitating commerce and access for emergency vehicles.

MDOT has jurisdictional responsibility for approximately 4,413 trunkline bridges having over 49 million square feet of bridge deck area. This includes all structures carrying or crossing the "I," "US," and "M" numbered highways. The state's 83 county road commissions are responsible for about 5,608 bridges having 11.5 million square feet of deck area; the cities and villages are responsible for 790 bridges having 4.7 million square feet of deck area.

Table 10 shows the number of bridges owned by MDOT versus those owned by counties and municipalities, along with their respective sizes by deck area. The size of a bridge's deck area is a key determinant in how much it costs to maintain, repair, or replace that bridge.

Nearly 1,700 of MDOT's bridges are on major freeways (I-75, I-94, I-96, or I-69). Maintaining, rehabilitating, and replacing these bridges involves unique financial and planning challenges. These roadways carry large traffic volumes. Work needs to be coordinated so user delays are kept to a minimum. Cost to do work on these bridges is expensive because of extensive maintenance of traffic and the larger size and complexity of these bridges.

Table 10: Highway Bridges

Owner	*Number of Highway Structures*	*Square Footage in Millions*	*Percent of Total Square Footage*
MDOT Freeway	3,198	41.2	63%
MDOT Non-Freeway	1,215	7.9	12%
Local – County	5,608	11.5	18%
Local – Cities and Villages	790	4.7	7%
Total Highway	10,811	65.3	100%
Highway Bridges on Major Freeways			
I-75	568	10.3	15.7%
I-94	482	6.6	10.2%
I-96	363	4.7	7.2%
I-69	300	3.1	4.7%

Source: Michigan Department of Transportation, Transportation Management System

2.3.2 Bridge Condition

2.3.2.1 National Bridge Inventory (NBI)

There are several methods available to rate and describe the condition of MDOT bridges. The most common of these methods is the Federal Highway Administration's (FHWA) National Bridge Inventory (NBI) condition rating system. Since the FHWA requires inspection of all highway bridges over 20 feet long, in accordance with the National Bridge

Inspection Standards (NBIS), this method is well known and used by all state and local agencies. MDOT has been using the NBI condition rating system to rate and report bridge condition, set goals, compare conditions within Michigan, and benchmark against other states.

2.3.2.1.1 NBI Rating Scale

The NBI inspection is a visual survey to determine bridge condition and ensure safety. The NBI rating system uses 10 separate ratings, with zero being the worst and nine being a new structure. Descriptions for each rating are provided by FHWA's *Recording and Coding Guide for the Structural Inventory and Appraisal of the Nation's Bridges*. Condition ratings are given for the three major elements of a bridge: (1) the deck, which consists of the riding surface and structure that directly carries vehicle loads, (2) the superstructure, which consists of the beams, girders, and stringers that support the deck, and (3) the substructure, which consists of piers and abutments that support the superstructure and transfer all loads to the earth. There is a separate overall condition rating for culverts, since this type of structure does not have the same elements as typical bridge structures. NBI ratings are given to all highway bridges, pedestrian bridges, and railroad bridges. MDOT is required by federal regulations to collect, store, and report NBI information to the FHWA annually.

Using the NBI scale, an element rated seven through 10 is considered as being in good condition. For structures having elements in this condition, MDOT does capital scheduled maintenance, which can be superstructure washing, vegetation control, drainage system cleaning or repair, spot painting, joint repair or replacement, concrete sealing, minor concrete patching and repair, concrete crack sealing, approach pavement relief joints, and slope paving repair. The purpose of capital scheduled maintenance is to sustain the structures' good condition.

Bridge elements rated five and six are considered in fair condition. Structures that are fair are candidates for CPM, which includes joint replacement, pin and hanger replacement, partial or complete painting, epoxy overlays of the bridge deck, deck patching, installation of scour counter measures, and hot mix asphalt overlays of the bridge deck. CPM addresses the needs of fair bridges to prevent them from becoming poor.

A bridge element rated four is considered poor. A condition rating of four or below is important information because bridges that have become poor require rehabilitation or replacement of the poor elements or the entire bridge. For this reason, MDOT monitors the number of bridges having one of the major elements (deck, superstructure, substructure) rated poor or worse. If any of these elements are rated four or below, the bridge is considered to be poor. Conversely, if all of the major elements are rated five or above, the bridge is considered to be good or fair. MDOT's bridge condition goals use this as a performance measure, and it has proven to be very helpful in monitoring MDOT progress.

2.3.2.1.2 MDOT Bridge Conditions

Figure 6, Figure 7, and Figure 8 show statewide trunkline bridge conditions (combined freeway and non-freeway), freeway bridge conditions, and non-freeway bridge conditions, respectively. The charts show that since the development of the Strategic Investment Plan for Trunkline Bridges was developed, MDOT has made steady progress to improve the condition of MDOT's bridges. In 2005, 83.9 percent of freeway bridges were in good or fair condition, 84.6 percent of non-freeway bridges were in good or fair condition, and 84.1 percent of state trunkline bridges were in good or fair condition.

Figure 6: Bridge Condition on Statewide System

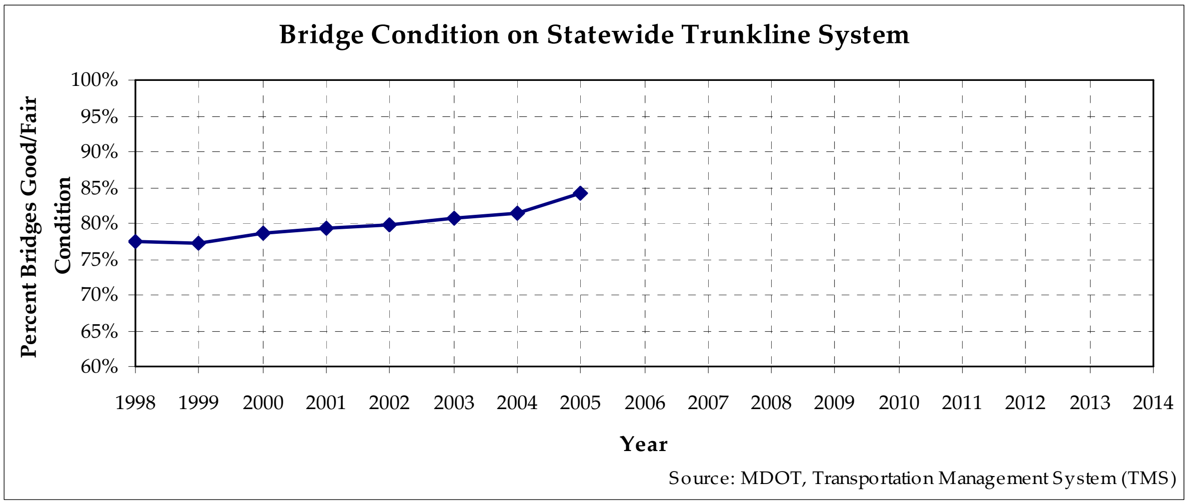


Figure 7: Bridge Condition on Freeway System

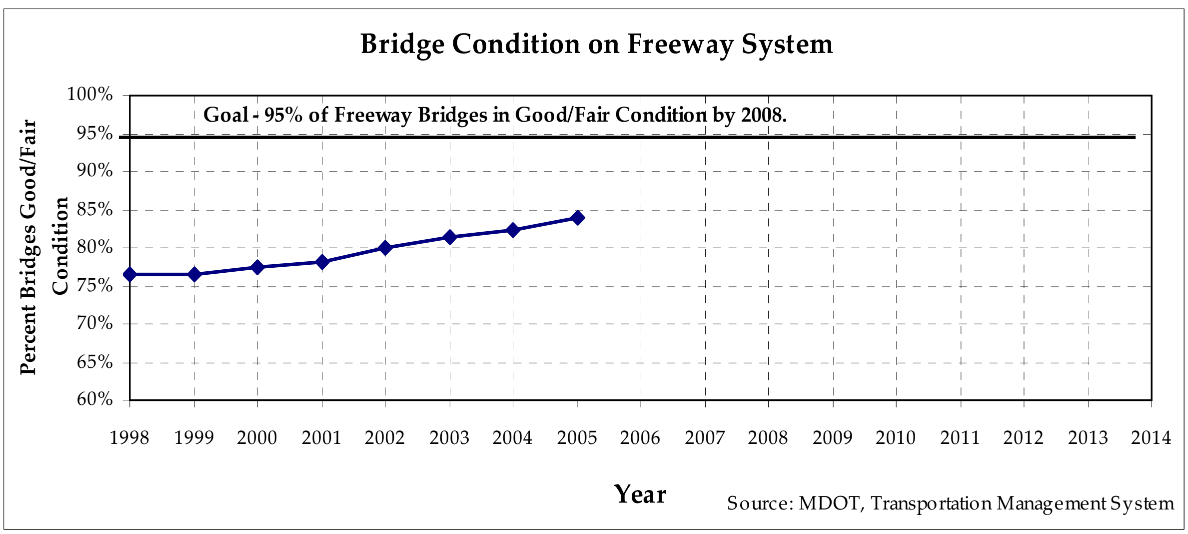
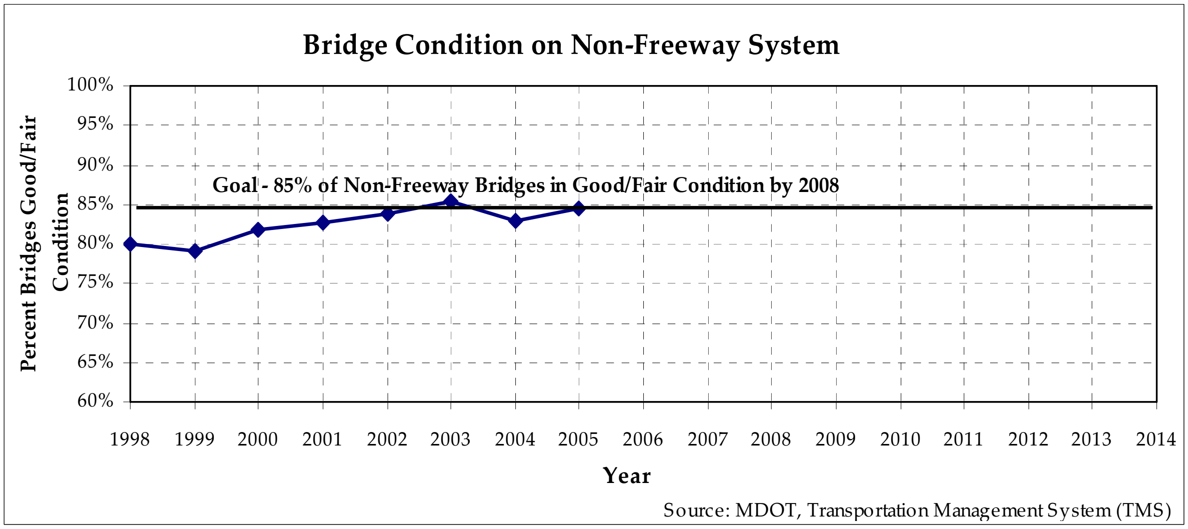


Figure 8: Bridge Condition on Non-Freeway System



2.3.2.2 Condition of Specific Elements

Besides the required NBI elements, MDOT and most local agencies use the NBI rating scale to survey the condition of state specific elements including deck surface, expansion joints, other deck joints, railings, sidewalks and curbs, drainage structures, paint, section loss, bearings, slope protection, approach pavement, approach shoulders, approach slopes, utilities, and drainage culverts.

NBI condition ratings provide a good overall assessment of bridge condition that is easily understood and reported. Along with the NBI rating, detailed and descriptive comments are provided, which can be used for more in-depth review of bridge condition.

2.3.2.3 Structurally Deficient and Functionally Obsolete

NBI condition ratings can also be used to classify a bridge as Structurally Deficient (SD) or Functionally Obsolete (FO). SD and FO are long-standing and very common performance measures for bridges. They are required by the FHWA and used by all the states. Following are definitions for each.

2.3.2.3.1 Structurally Deficient

Generally, a bridge is SD if any major component is in poor condition or if the structure has insufficient load carrying capacity or insufficient waterway (beneath the structure). If any one or more of the following are true, then the bridge is SD:

- Deck rating is less than five;
- Superstructure rating is less than five;
- Substructure rating is less than five;
- Culvert rating is less than five;
- Structural evaluation is less than three; and/or

- Waterway condition is less than three.

2.3.2.3.2 Functionally Obsolete

Generally, a bridge is FO if its clearances are significantly below current design standards for the volume of traffic being carried on or under the bridge. Bridges that are FO no longer meet current highway design standards, often because of narrow lanes, inadequate under clearances, or poor alignment. If any one or more of the following are true, then the bridge is:

- Structural evaluation is less than four;
- Deck geometry is less than four;
- Under clearance is less than four and there is another highway under the bridge;
- Waterway adequacy is less than four; and/or
- Approach roadway alignment is less than four.

A bridge cannot be classified as both SD and FO. If a bridge qualifies for both, then it is reported as SD. While FO bridges represent needed improvements, if the overall system is to achieve maximum operating efficiency, the bridges rated SD require more immediate attention.

The following charts show the condition of MDOT and local agency bridges (city, village, and county). **Table 11** shows the number of bridges each owner has based upon the number of SD and FO bridges. **Table 12** shows the deck area of SD and FO bridges.

Table 11 : Number of Bridges Structurally Deficient or Functionally Obsolete

Owner	*Number of Highway Structures*	*Number SD*	*Number FO*	*Number SD/FO*	*Percent*
MDOT Freeway	3,198	489	567	1,056	33.0%
MDOT Non-Freeway	1,215	173	86	259	21.3%
Local – County	5,608	940	469	1,409	25.1%
Local – City and Villages	790	125	147	272	34.4%
Total Highway	10,811	1,727	1,269	2,996	27.7%

Source: Michigan Department of Transportation, Transportation Management System (TMS)

Table 12: Deck Area of Bridges Structurally Deficient or Functionally Obsolete, Millions of Square Feet

Owner	*Deck Area of Highway Structures*	*Deck Area SD*	*Deck Area FO*	*Deck Area SD/FO*	*Percent*
MDOT Freeway	41.2	6.9	8.0	14.9	36.1%
MDOT Non-Freeway	7.9	1.3	0.9	2.2	27.8%
Local – County	11.5	1.3	1.5	2.9	24.8%
Local – City and Villages	4.7	0.7	1.0	1.7	35.3%
Total Highway	65.3	10.2	11.4	21.6	33.1%

Source: Michigan Department of Transportation, Transportation Management System (TMS)

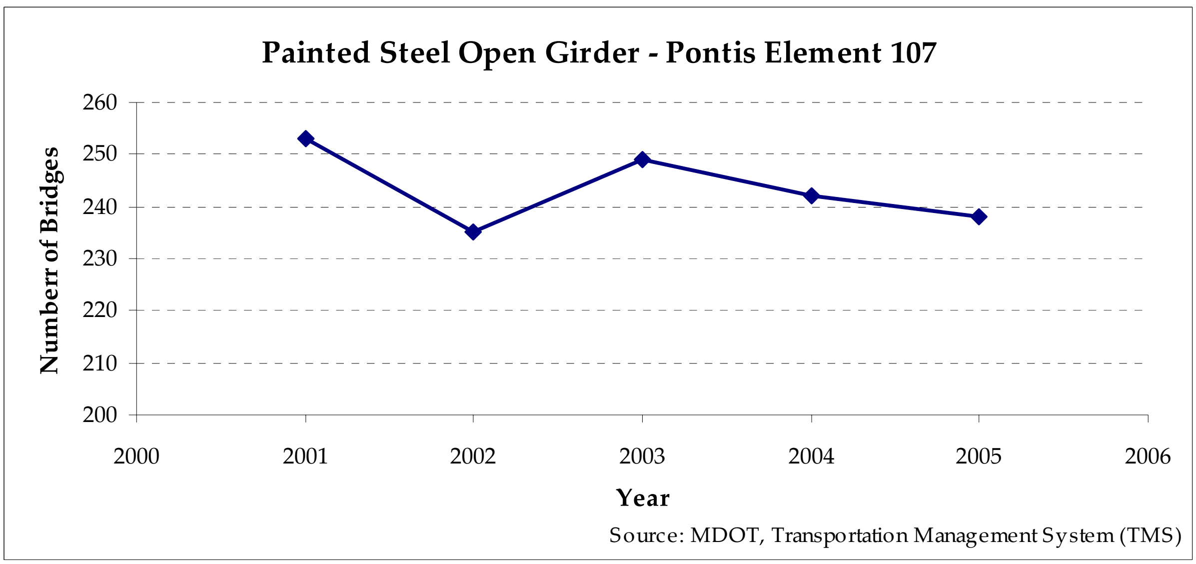
2.3.2.4 Commonly Recognized (CoRe) Structural Elements

In addition to the NBI condition ratings, MDOT and some local agencies collect separate condition ratings for bridges and culverts using the American Association of State Highway Transportation Officials' (AASHTO) *Guide for Commonly Recognized (CoRe) Structural Elements*. For this condition rating system, a bridge is divided into CoRe elements. These elements are similar to the NBI elements (deck, superstructure, and substructure); however, the CoRe elements provide more detail, such as the type of beams the superstructure uses and what steel reinforcement is in the deck. CoRe elements are also provided for less major components of the bridge, such as expansion joints, pin and hangers, and pier columns.

Similar to the NBI condition ratings, CoRe element ratings are visual. Unlike the NBI ratings, CoRe element ratings include a quantity for each element; for many elements, the quantity of the element can be separated into different condition ratings. For example, a superstructure having 1,000 linear feet of painted steel beam can have 900 linear feet in good condition, 90 linear feet in fair condition, and 10 linear feet in poor condition.

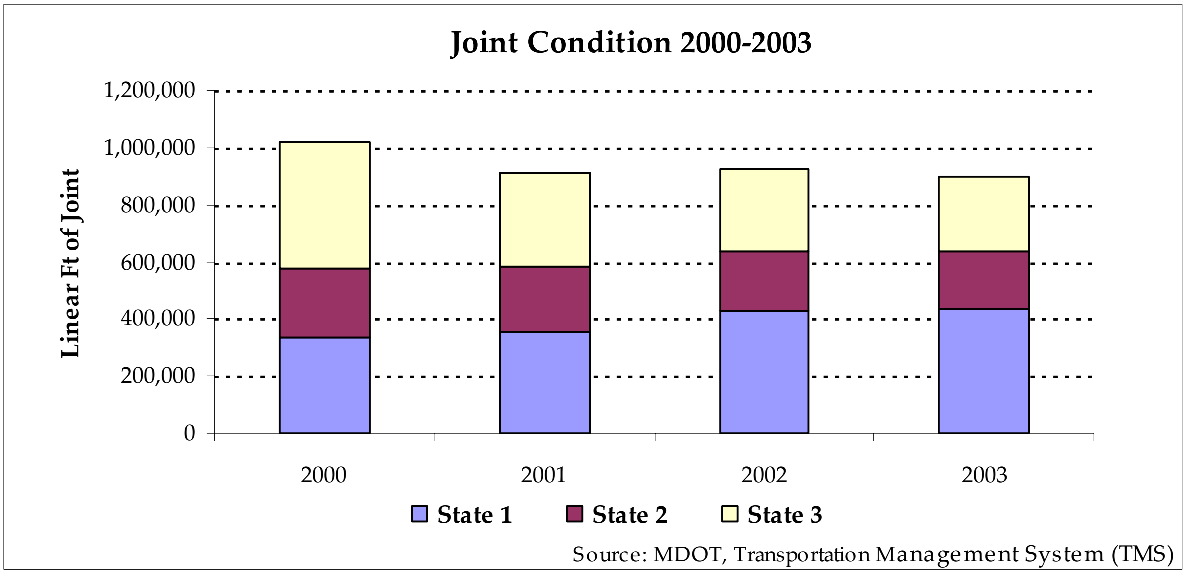
MDOT is reviewing CoRe element condition data, and modifying it as needed to meet the department's asset management needs and business practice. CoRe elements are proving to be most useful for determining preventive maintenance needs, as shown in **Figure 9** and **Figure 10**.

Figure 9: Possible Zone Painting Candidates



Note: Pontis is a comprehensive bridge management system that provides a set of modeling and analysis tools to support project development, budgeting, and program development.

Figure 10: Expansion Joint Condition



Note: State 1 = Expansion joints in good condition; State 2 = Expansion joints leaking or in need of repair; State 3 = Expansion joints requiring replacement.

2.4 Highway Non-Pavement Infrastructure Inventory

2.4.1 Carpool Parking Lots

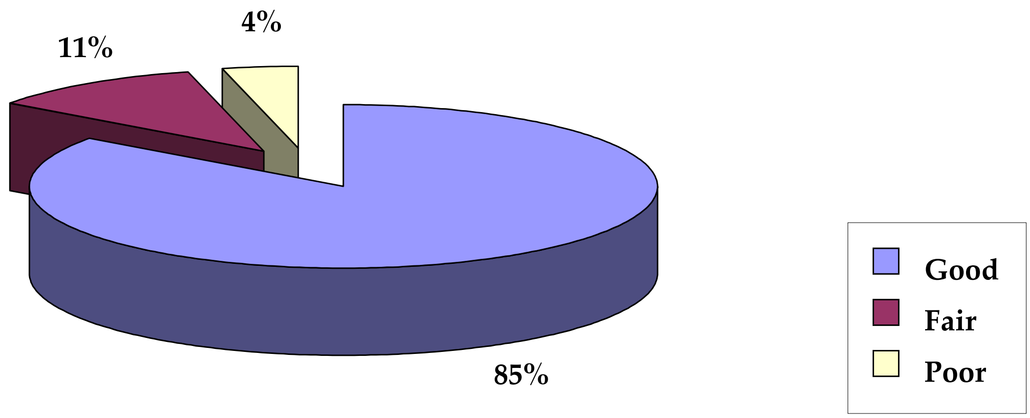
Carpool parking lots (CPLs) are used as rendezvous points for parties traveling or commuting together, and as facilities where they can park unneeded vehicles until their return. MDOT manages more than 200 CPLs, of which 182 (84 percent) are located within MDOT right-of-way (ROW). The rest are owned by local units of government or leased from private property owners. As of 2005, the system had 217 CPLs spread across the state. Approximately 75 percent of CPLs are paved and 25 percent are gravel.

CPLs are evaluated using the PASER system, a 1 to 10 scale measuring the condition of road surfaces. For CPLs the following categories are used:

- Good – PASER rating of 6-10;
- Fair – PASER rating of 4-5; and
- Poor – PASER rating of 1-3.

As shown in **Figure 11**, at the end of 2005, 85 percent of the CPL system was in good condition (PASER rating between 6 and 10), and 96 percent of the system was in fair or good condition (PASER rating of 4 or greater). The overall average PASER rating for the system was 7.2 out of 10. CPL inspections are usually performed during the summer months and, thus, 2005 is the last year for which data are available.

Figure 11: 2005 Carpool Parking Lot Conditions



Source: Michigan Department of Transportation, Transportation Management System (TMS)

2.4.2 Rest Areas, Scenic Turnouts, and Welcome Centers

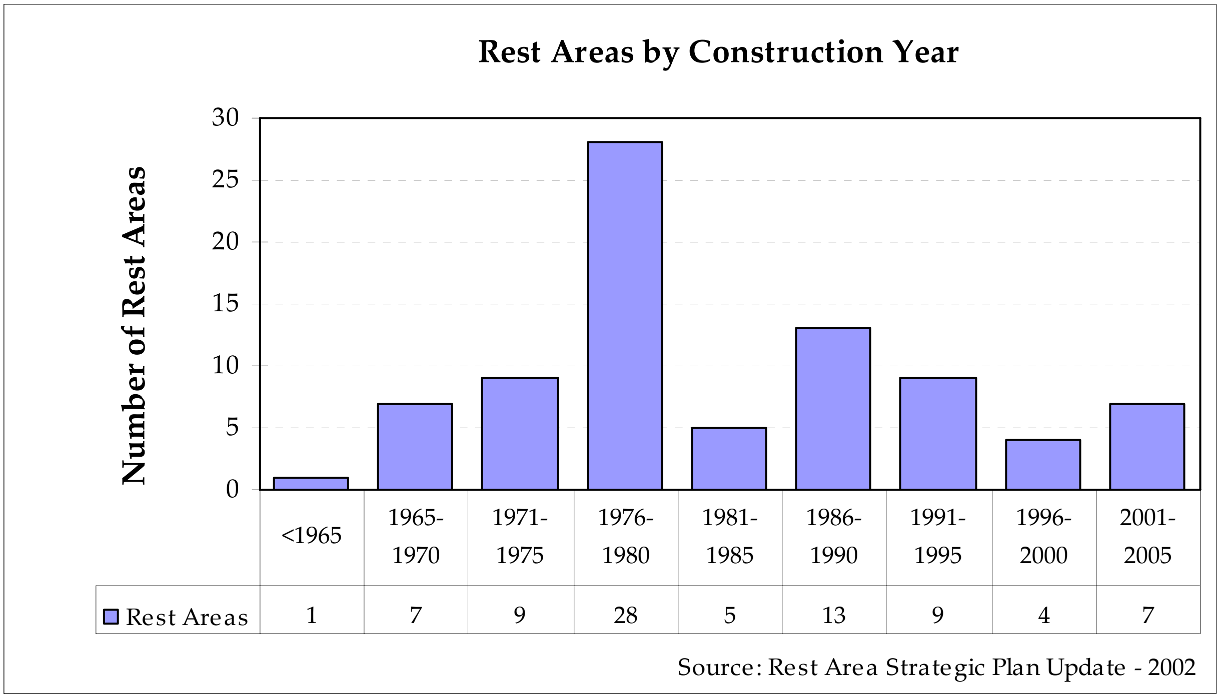
2.4.2.1 Rest Areas

MDOT rest areas and roadside parks are part of the trunkline highway system.[8] They are a valuable asset to MDOT and a primary point of contact with the public. The role of the rest area has evolved from the "safety rest area" to facilities that support travel and tourism and serve as an important marketing and public contact tool for those states competing for tourist dollars. These facilities provide the contact and communication point between MDOT and the people they serve. In order to meet the needs of that public, MDOT must continue to provide high-quality facilities that MDOT's customers feel comfortable using and the department can be proud to call MDOT facilities.

In September of 1992, the Rest Area/Welcome Center Strategic Plan was completed and presented to the Highway Steering Committee. Many goals were identified as part of the 1992 plan and have been incorporated into the new building plans and developments. Since then the Roadside Development Program has invested approximately $5 million per year in direct rest area improvements on facilities that serve approximately 50 million visitors at its 85 rest area facilities every year. This direct investment to the rest area program was later increased to $9 million annually in 2004. **Figure** 12 summarizes the 83 rest areas by the year they were constructed. Two of MDOT's 85 rest areas are excluded from this summary; one is a rustic rest area and the other is closed.

[8] Source: Executive Summary, *Rest Area Strategic Plan Update* – 2002

Figure 12: Number of Rest Areas by Construction Year



Currently 37 rest areas have 500,000 or more visitors each year, with only 60 percent of those being of the current design and considered in good condition at the end of 2005. Those facilities that receive the greatest use are the highest priority and need replacement or renovation. While not all facilities are high-use, serving 500,000 or more visitors per year, the traveling public still expects basic needs and services and requires facilities that can provide unlimited access. These facilities shall meet current barrier free access codes, contain infrastructure that meets current codes and standards, and have site amenities consistent with current standards of the Roadside Development Program. **Table 13** displays rest area attendance information indicating that 44 percent of MDOT's rest areas are serving over 500,000 visitors every year.

Table 13: Rest Area Attendance

Annual Attendance	*Number of Rest Areas*	*Percent*
Less than 100,000	6	7.1%
100,000 – 199,999	10	11.8%
200,000 – 299,999	9	10.6%
300,000 – 399,999	11	12.9%
400,000 – 499,999	12	14.1%
500,000 and over	37	43.5%
Statewide Total	85	100.0%

Source: Rest Area Strategic Plan Update, Table A-Attendance Ranking

2.4.2.2 Scenic Turnouts and Welcome Centers

Scenic turnouts are also managed within MDOT's Rest Area/Roadside Park Program. Currently there are 31 scenic turnouts throughout the state along the trunkline system. They are included in the Five-Year Capital Outlay and Facilities Maintenance Plan.

MDOT also has 13 welcome centers that are jointly operated with the Michigan Economic Development Corporation (MEDC). MDOT maintains ultimate control over these facilities and is responsible for repairs, replacements, and upgrades to the facilities and grounds via capital outlay appropriations. MDOT contracts with MEDC for the administration of the daily welcome center operations.

2.4.3 Drainage

MDOT's statewide highway system includes an extensive engineered drainage system, which serves two distinct design functions. The first purpose is structural: to convey water away from the road to support pavement integrity. The second is to manage and convey storm water runoff from the roadway throughout the highway system and eventually back into the environment. Efforts are underway as part of the new MDOT storm water management plan, and in coordination with the department's asset management program, to inventory storm water system features including identification and mapping of outfalls, and inventorying of storm water control structures. A database has been developed to organize this data as it is compiled.

2.4.4 Weigh Stations

From 1960-1980, MDOT invested in a system of weigh stations to support weight enforcement, primarily along interstate highways in southern Michigan. Motor carrier safety enforcement was formalized in the 1980s and safety inspection of vehicles was particularly emphasized as a targeted activity to be conducted along with weigh station operations.

While MDOT provides the weigh station infrastructure, the facilities are operated by the Michigan State Police, Motor Carrier Division (MSP/MCD). In the late 1990s, agreements were executed with MSP/MCD to de-emphasize traditional weigh station operations at the interior weigh stations and shift enforcement to more mobile patrols. Weigh stations located at Michigan's southern border (inbound) were retained and MDOT began working on technological tools to provide greater support for mobile patrols.

In addition, there are also numerous rest areas and other public infrastructure that qualify as safe places to weigh and inspect trucks. There are also 17 truck safety turnout locations in the Upper Peninsula. These sites were mandated in MDOT's appropriation bills for the past several years. The intent of these sites is to provide a safe place for log trucks to stop and secure their loads, reducing the incidence of log spills and accidents.

2.4.5 Non-Motorized Facilities

Non-motorized facilities within MDOT ROW provide bicyclists and others with a network that supports a variety of non-motorized transportation alternatives. These non-motorized facilities can take many forms, both on-road and off-road. The on-road facilities may include paved shoulders, bike lanes, and wide curb lanes. Off-road facilities can include shared-use pathways or sidewalks.

These on-road and off-road facilities are spread across the state in both urban and rural areas. In terms of on-road facilities, in 2005 MDOT maintained more than 2,550 miles of non-freeway trunkline with paved shoulders greater than four feet. These paved shoulders are often the best way to accommodate bicyclists in rural areas and also provide benefits to motor vehicles. Wide curb lanes, or the right-most lane of a road 14 feet or greater in width, are additional facilities considered safe for shared use by bicycles and motor vehicles. Bike lanes are those designated specifically for carrying bicycle traffic in the same direction as the adjacent motorized traffic. Inventories of wide curb lanes, bike lanes, and retrofit lanes are not available and often difficult to accurately track.

Off-road facilities such as shared-use paths and sidewalks within MDOT ROW are intended exclusively for non-motorized users such as bicyclists and pedestrians. One example of a shared-use path within MDOT ROW is the I-275 bike path located in the Detroit Metropolitan area. This eight-foot-wide path runs the entire 40-mile length of I-275. MDOT has allowed the construction of other shared-use paths and sidewalks within ROW in other areas of the state. Since MDOT does not maintain these facilities, an accurate inventory of them is not available.

2.4.6 Type II Noise Abatement Barriers

Currently there are 30 Type II noise abatement barriers located along MDOT's trunkline system. These Type II barriers are found predominantly in five counties of southern Michigan. As shown in **Table 14**, the five counties are Wayne, with 16 barriers, Washtenaw, with one barrier, Macomb, with seven barriers, Oakland, with four barriers, and Kalamazoo, with two barriers. The barriers are located along existing highways and interchanges in proximity of large residential areas where road noise exceeds an acceptable level. Type II noise abatement barriers are also used in areas of serenity, public need, recreation areas, and in developed lands and properties.

Table 14: Type II Noise Abatement Barrier Locations

County	#
Wayne	16
Washtenaw	1
Macomb	7
Oakland	4
Kalamazoo	2
Total	**30**

2.4.7 Replacement of Existing Freeway Lighting Program

The Replacement of Existing Freeway Lighting Program is a new program to the MDOT road and bridge capital outlay program. The intent of the Freeway Lighting Rehabilitation Program is to identify and prioritize freeway lighting in need of rehabilitation. The department acknowledges the need for rehabilitation and has committed resource dollars for the next 10 years to accomplish this effort.

The department owns over 200 miles of continuous freeway lighting utilizing either median-mounted lights or shoulder-mounted lights. There are also 70 illuminated interchanges with 50 of those illuminated by tower lights (or high-mast lighting). The majority of freeway lighting is in Metro, Grand, Bay, and University regions. In the Metro Region alone, the department owns 104 miles of continuous freeway lighting and 40 interchanges illuminated with tower lights (high-mast lighting). It is reasonable to suggest that rehabilitation efforts will be concentrated in regions with the most existing freeway lighting.

2.4.8 Pump Station Capital Rehabilitation Program

The intent of the Pump Station Capital Rehabilitation Program is to identify and prioritize storm water pump stations in need of complete electromechanical rehabilitation. Currently, the department acknowledges the need for rehabilitation and has committed resource dollars for the next nine years to accomplish this effort.

The department owns 169 pump stations. All regions have at least one pump station, with Bay, University and Metro having, progressively, the most. In Wayne County alone, the department owns 118 such facilities. The Maintenance Support Area (MSA), in conjunction with the Metro Region and the Wayne County Department of Public Works currently performs and supports routine and emergency pump station maintenance services from the existing Maintenance Program. The Pump Station Capital Rehabilitation Program complements the current pump station maintenance program. It is reasonable to suggest that rehabilitation efforts must be concentrated in urban areas with larger populations of pump stations.

2.4.9 Snowmobile Crossings

The Superior Region maintains 107 snowmobile crossings of official Michigan Department of Natural Resources (MDNR) trails throughout the Upper Peninsula. Carbide tips on snowmobile skis, and traction spikes on the tracks, damage the shoulders, roadways, and bridges and create ruts in the slopes. The region set aside some funding to maintain the pavements at these crossings for condition and safety.

Chapter 3. Highway Pavement, Bridge, and Highway Non-Pavement Condition

This condition and performance section will address current pavement and bridge conditions based on available data and discuss the trend for Michigan highways into the future. Michigan's RQFS, using RSL measurements, BMS using available bridge inventory and performance data, and other tools will form the basis of this analysis.

The recent performance history of Michigan's highway pavements and bridges will be reviewed in light of goals set to establish a recent trend in highway pavement and bridge condition by freeway and non-freeway. The future forecast for Michigan's highway pavements and bridges will be analyzed and compared relative to the identified system condition goals. This section will also address the goals and conditions for non-pavement infrastructure programs where data are available.

3.1 Highway Pavement Condition Goals and Projected Trend

3.1.1 Highway Pavement Condition Goals

In 1997, MDOT's roads and bridges were in significant need of improvement. Nearly 40 percent of the system was rated poor and becoming worse. The condition of the system was simply not acceptable. Pavement condition was the number one issue in the news media. After many years of focus on building new infrastructure, the emphasis in the state needed to shift from expanding the system to preserving and maintaining the system. At that time, the last of the major freeway links and expansions (I-69, I-696, M-5, US-127, to name a few) was completed.

Even though the public was concerned and vocal about the poor condition of Michigan's highways, MDOT and other governmental agencies did not have the appropriate resources to begin to address the significant needs. With the help of RQFS, MDOT was able to show the legislature what could be achieved and provide an estimate of how much it would cost to begin to improve and rebuild Michigan's aging transportation infrastructure. The strategy analysis, along with the forecasting capabilities, provided the tools to show the need for additional revenues, such as the increase in Michigan's gas tax in 1997, to begin to address these needs. The increased gas tax, along with the funding increases in the federal legislation of ISTEA and TEA-21, which were passed by Congress, provided much needed additional revenue to Michigan for the transportation system.

In the fall of 1997, to direct the investment of the funding raised by the gas tax increase, MDOT proposed a goal to the State Transportation Commission (STC) to improve and maintain 85 percent of the trunkline system to good condition. Over the course of several months, the goal was fine-tuned to improve 95 percent of the freeway and 85 percent of the non-freeway to good condition by the end of 2007.

At the same time, a major internal shift in focus was taking place within MDOT. The department was becoming much more customer-oriented and results-driven. Key initiatives in this regard included the establishment of Transportation Service Centers, the creation of the annual Five-Year Transportation Program document, and the acceleration of project lettings to the first two quarters of the fiscal year. As a result of these initiatives, the department closed over 25 offices, consolidated key services in locations that were closer to the customers, and published promises of what and when MDOT would deliver in the Five-Year Transportation Program. All these initiatives were designed to make the department be more responsive and accountable to customers and their expectations. All these initiatives have been successful.

As MDOT addressed the system condition problems, it sought to find ways to have lasting results. It could have taken an expedient approach that called for minor resurfacing of the entire system. This would have provided an immediate improvement to a large portion of the system, but would have resulted in the entire system becoming poor again in a few short years. Instead, MDOT took a strategic approach, the asset management approach, to do the right mix of fixes that would improve the overall health of the system for the long term.

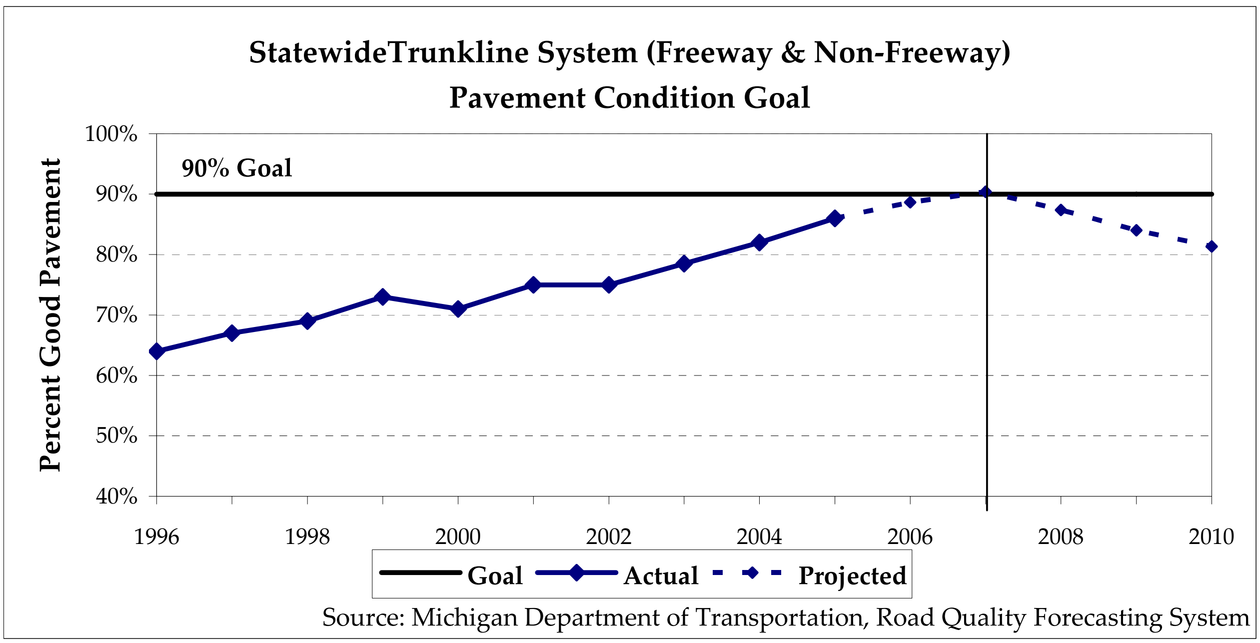
During the past nine years, MDOT has worked to improve the trunkline system while trying to accomplish significant additional efforts. MDOT has incorporated many more miles of freeway reconstruction to improve the health of the network, to increase the safety aspects of projects and take care of additional needs, such as, ramp improvements, repairing shoulders, improving roadway drainage, and improving freeway lighting.

MDOT has also committed to rebuild aging infrastructure in urban areas that have proven to be very expensive. These urban area projects were limited significantly in the past because of funding shortfalls.

Despite many obstacles and significant increases in the cost of petroleum-based construction materials, MDOT has made significant progress toward achieving the pavement condition goals. In the following pages, several graphs will facilitate understanding of where we have been, how far we have come, and where we project to be in the future with current investment funding levels.

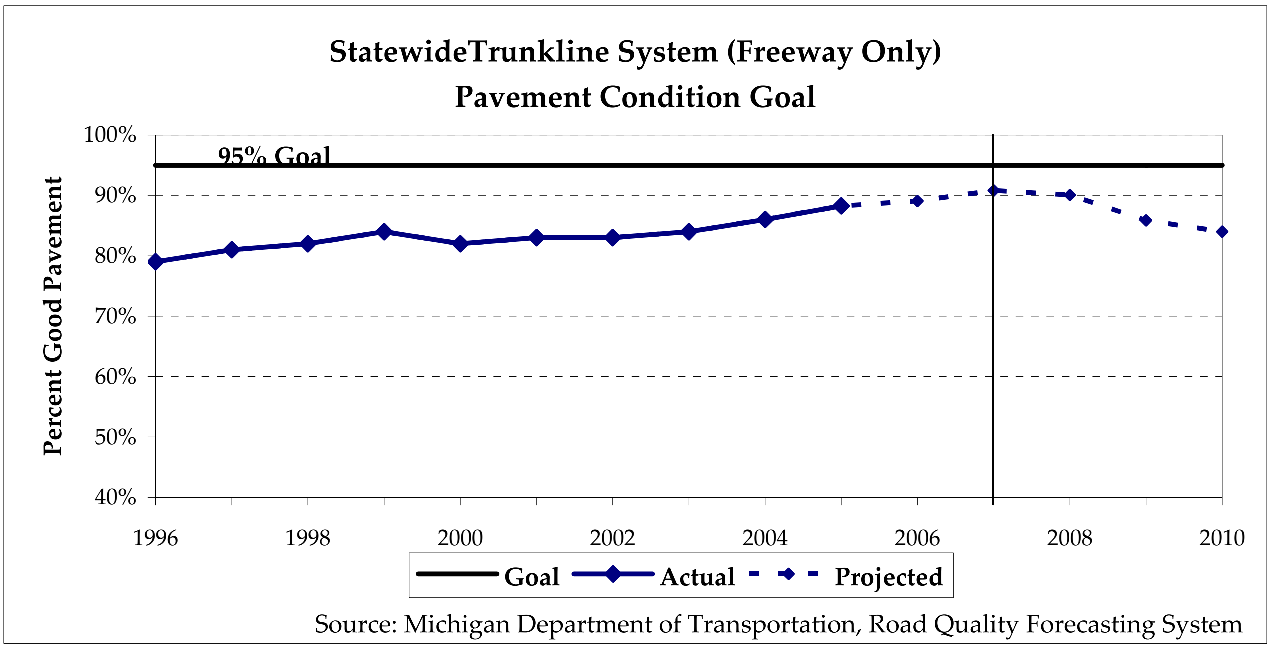
The first graph, **Figure 13** displays the pavement condition for the entire trunkline system (the combined freeway and non-freeway networks). The improvements from 1996 to 2005 are based on pavement and project data, while the forecast of improvements from 2006 to 2010 are based on the expected results from implementing planned construction programs along with expected deterioration. The graphs on the following pages were developed in a similar manner.

Figure 13: Short-Term Forecast Pavement Condition on Statewide Trunkline System



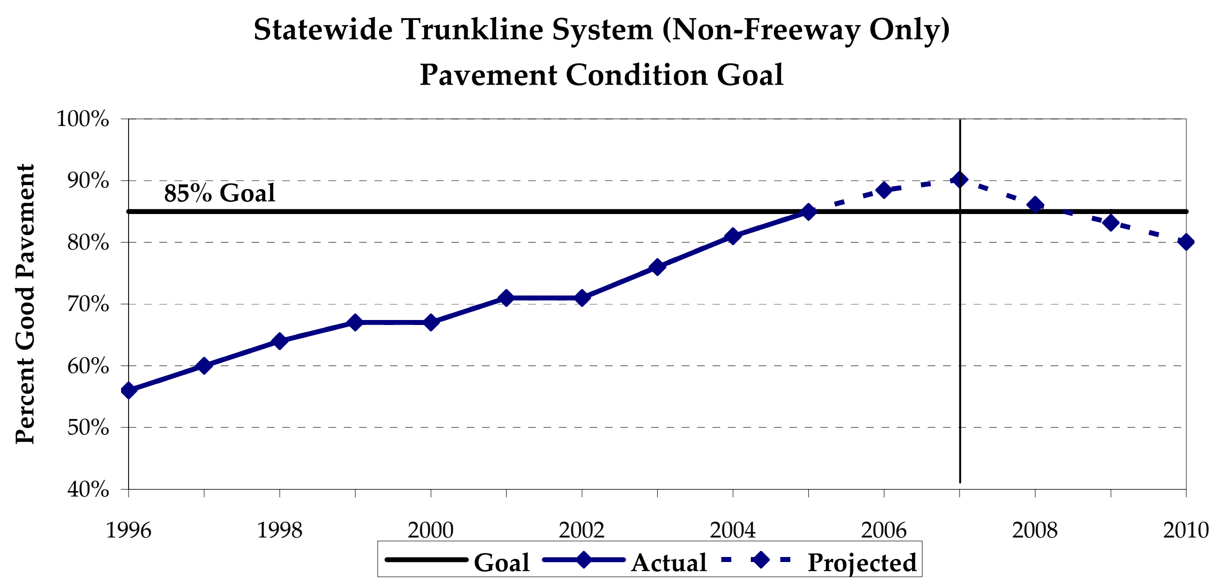
In **Figure 14** and **Figure 15,** the progress on the freeway and non-freeway networks is displayed separately. The significant improvement for each system is shown from 1996 and projected through 2007, MDOT's goal year. For the freeway system, the pavement condition is projected to be approximately 90 percent good in 2007 and sustained at that condition level through 2008. After year of 2008, the forecasted system condition, based on planned pavement projects, displays a downward trend indicating that MDOT will have difficulty maintaining the improved system condition into the future without additional funding (a similar trend for all networks).

Figure 14: Short-Term Forecast: Pavement Condition on Trunkline Freeway



For the non-freeway trunkline system, the starting point was much lower than the freeway system. **Figure 15** shows the significant progress that has been made to improve this system over the last 10 years, meeting our non-freeway goal (85 percent good) in 2005 and continued progress in 2006. In 2007, the system condition is projected to continue to improve, achieving approximately 90 percent good.

Figure 15: Short-Term Forecast: Pavement Condition on Trunkline Non-Freeway



Source: Michigan Department of Transportation, Road Quality Forecasting System

3.1.2 Highway Pavement Condition Projected Trend

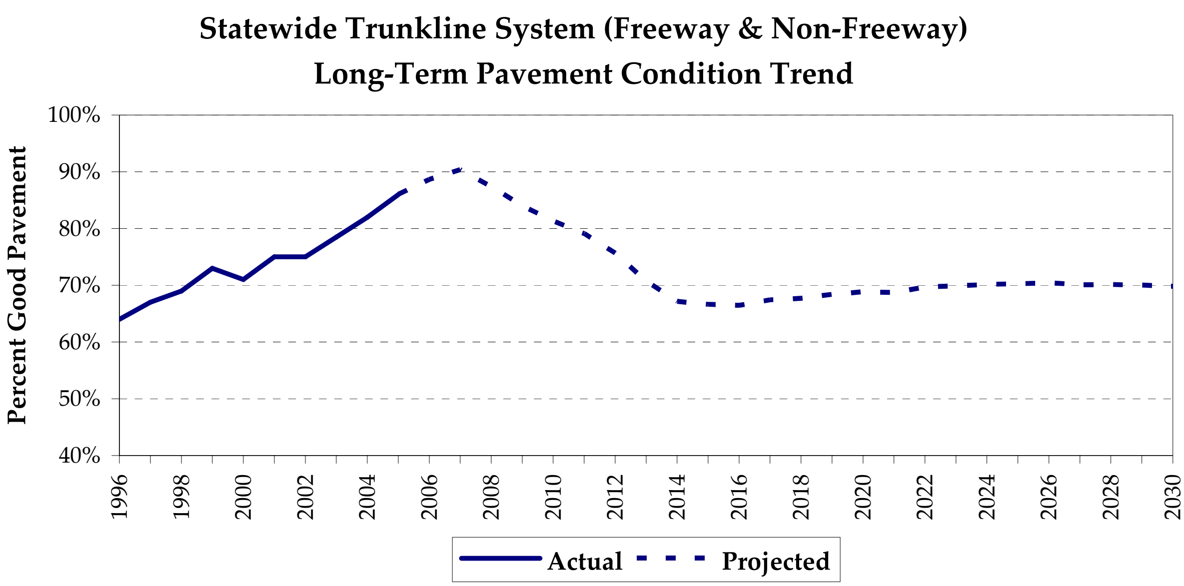
Based on continued investments, using today's funding levels, several longer-range forecasts of future conditions are presented in this section. In the past 10 years, the pavement condition improved from just over 60 percent good to 90 percent good. To achieve this goal, as stated previously, MDOT has used a mix of fixes approach to improve the system condition. The Preserve First and Jobs Today programs were additional funding resources through bonding to continue the progress that had been made into the early 2000s and to take us closer toward our established goals of improving the system to 90 percent in good condition. Since the bonded program funding levels will not be sustained into the future, it is projected that after a few years, the improved Michigan trunkline condition will begin to decline.

Some of the underlying factors contributing to this trend have been significantly increased project costs due to material cost increases, the need to address previously bypassed large and expensive urban renovation projects, updated and increased safety standards, additional non-pavement roadway needs, and a significant backlog of smaller urban reconstruction needs in which outdated sewer systems, improved traffic movements, and other small urban needs are addressed.

It is hoped and expected that through continued quality engineering practices, innovative development of emerging technologies, and a continuation of an excellent preventive maintenance program, MDOT, with its partners, will be able to minimize the cost increases needed in the future. MDOT will continue to strive to keep a balanced mix of fixes, pursue innovative ideas, and partner with stakeholders to achieve the best pavement conditions possible for the motoring public.

The projected long-term pavement conditions shown in **Figure 16** and subsequent figures are based on current funding levels.

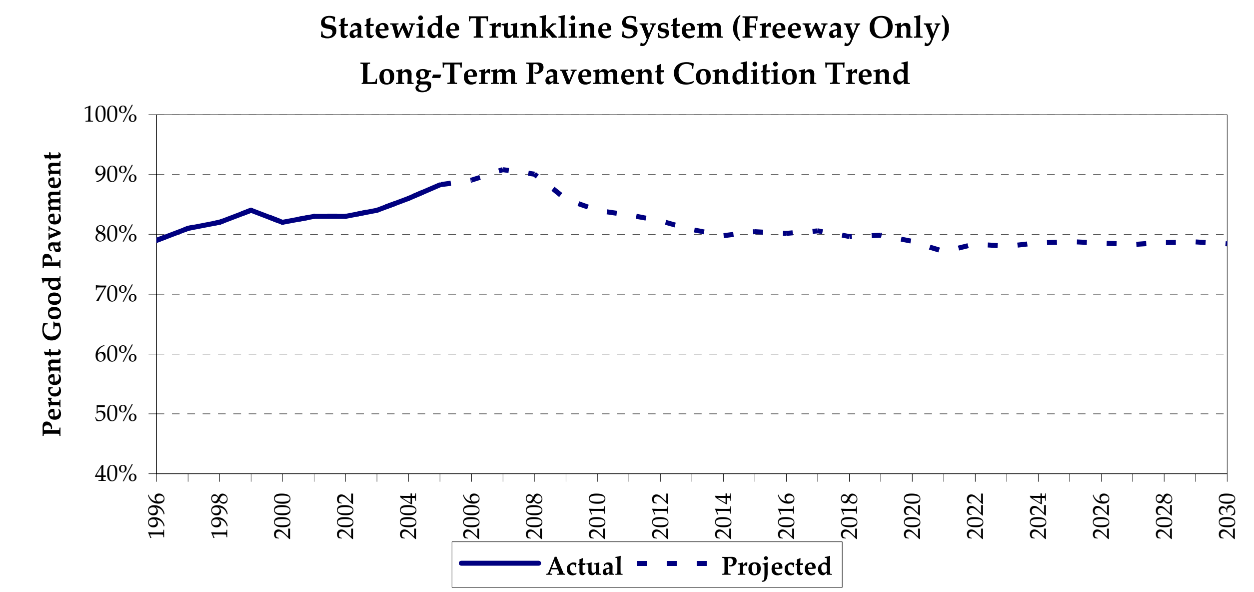
Figure 16: Long-Term Forecast: Pavement Condition on Statewide Trunkline System



Source: Michigan Department of Transportation, Road Quality Forecasting System

For the freeway network, the improvements made during the past 10 years will be sustained for a period, but will then slowly decline in the future, as shown in **Figure 17**.

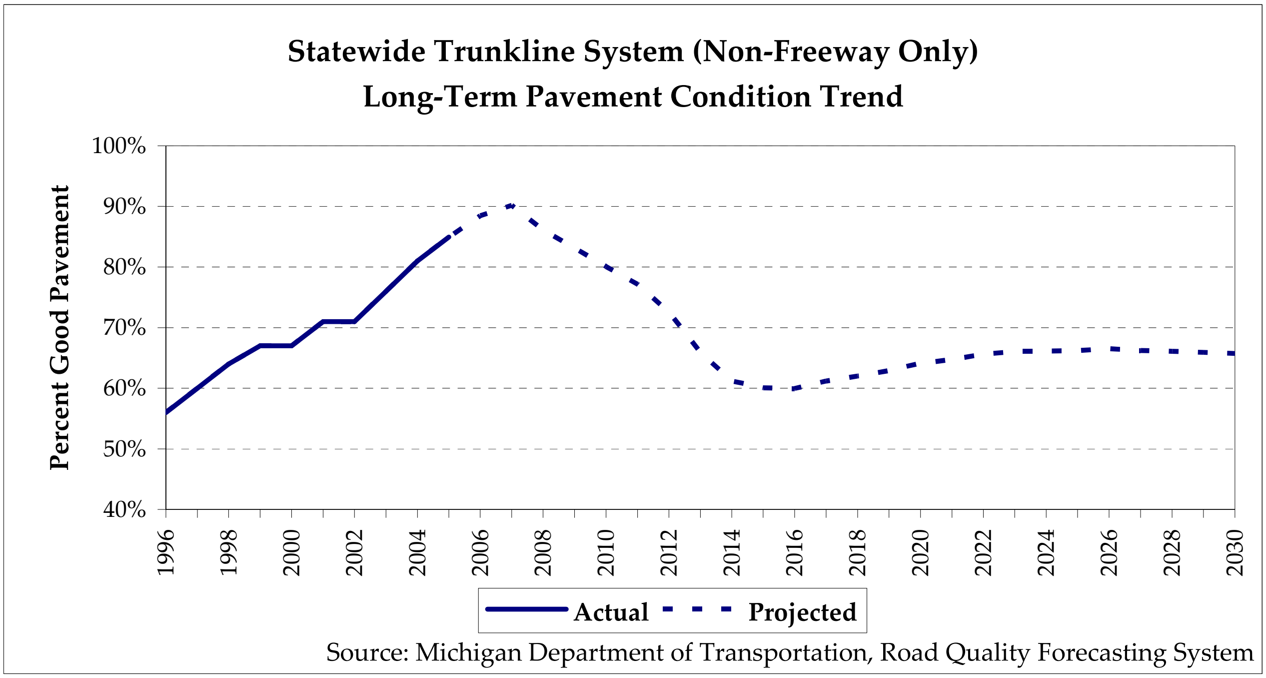
Figure 17: Long-Term Forecast: Pavement Condition on Trunkline Freeway



Source: Michigan Department of Transportation, Road Quality Forecasting System

As shown in **Figure 18**, the improvements achieved on the non-freeway network are quite pronounced during the period from 1996 to 2007, with pavement condition improving from approximately 57 percent good in 1996 to approximately 85 percent good in 2005. However, the projections beyond 2007 suggest that sustaining will be difficult with existing funding levels due to contributing factors discussed earlier.

Figure 18: Long-Term Forecast: Pavement Condition on Trunkline Non-Freeway



3.2 Highway Bridge Condition Goals and Projected Trends

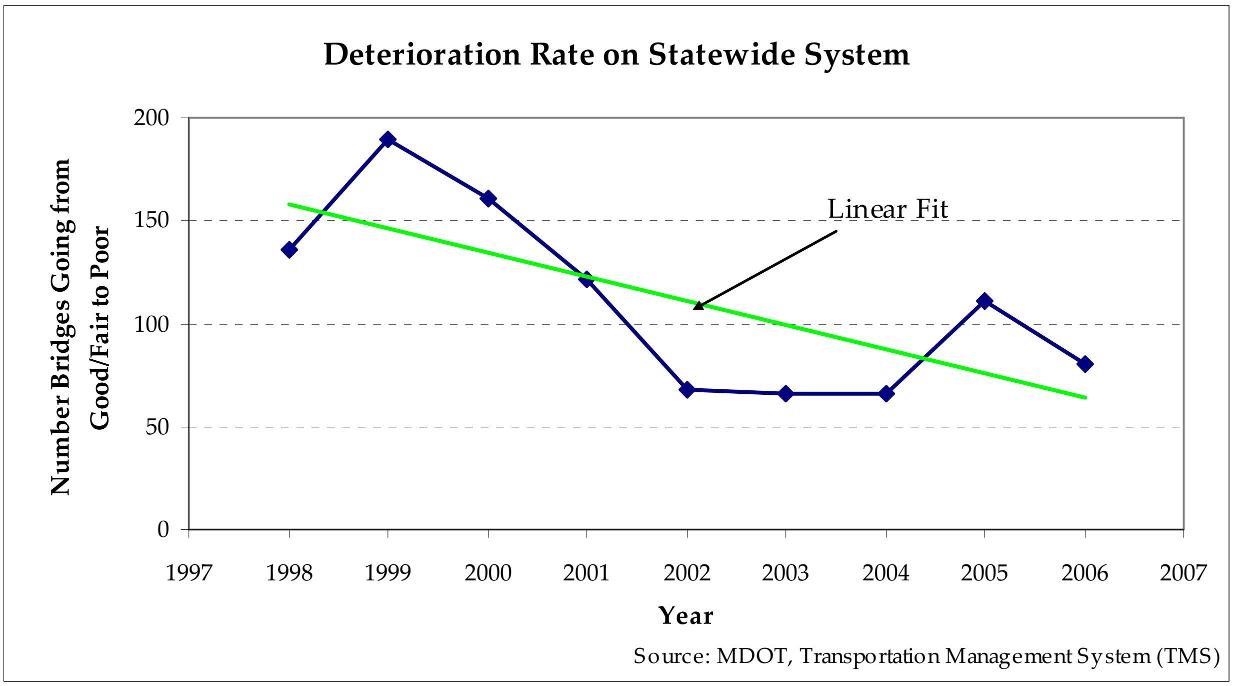
3.2.1 Bridge Management System

MDOT's BMS is an important part of the department's overall asset management process. BMS is a strategic approach to linking data, strategies, programs, and projects into a systematic process to ensure achievement of desired results.

An important BMS tool used by MDOT to develop preservation policies is the Bridge Condition Forecast System (BCFS). Using the NBI condition ratings, bridge deterioration rate, project cost, expected inflation, and fix strategies, BCFS estimates the future condition of the state trunkline bridge system. BCFS can compare a mix of fixes by modeling different percentages of preventive maintenance, rehabilitation, and replacement projects. Strategies can be modeled on the statewide trunkline network or by region.

Strategies developed using BCFS have proven to be very helpful in managing the trunkline bridge network. By doing a balanced mixture of preventive maintenance, rehabilitation, and replacement, MDOT has dramatically increased the number of bridges improved each year. In 1997, MDOT had fewer than 60 bridge projects. In 2004 and 2005, MDOT had over 300 bridge projects each year. At this rate, MDOT will work on each bridge in the network every 15 years. The department has also dramatically decreased the number of bridges falling into the poor category as shown in **Figure 19**.

Figure 19: Number of Bridges Going from Good to Fair to Poor



MDOT manages large and unique bridges separately. The complexity, large cost, and strategic importance of these bridges require more specialized expertise to inspect and manage them, so a centralized unit is dedicated to administration and strategic planning for these important structures.

3.2.2 Highway Bridge Condition Goals

In 1998, MDOT developed the Strategic Investment Plan for Trunkline Bridges. This plan has served as the framework for MDOT's BMS and it made a commitment to long-range strategic planning and investment in the trunkline bridge network. The strategic plan, along with MDOT's Call for Projects process, provides an integrated network management strategy that is necessary to achieve the network condition goals in a cost-effective manner.

The goal of MDOT's Strategic Investment Plan for Trunkline Bridges is to preserve the trunkline bridge network to ensure safety and serviceability, while optimizing all available resources. Specifically, the network condition goals are:

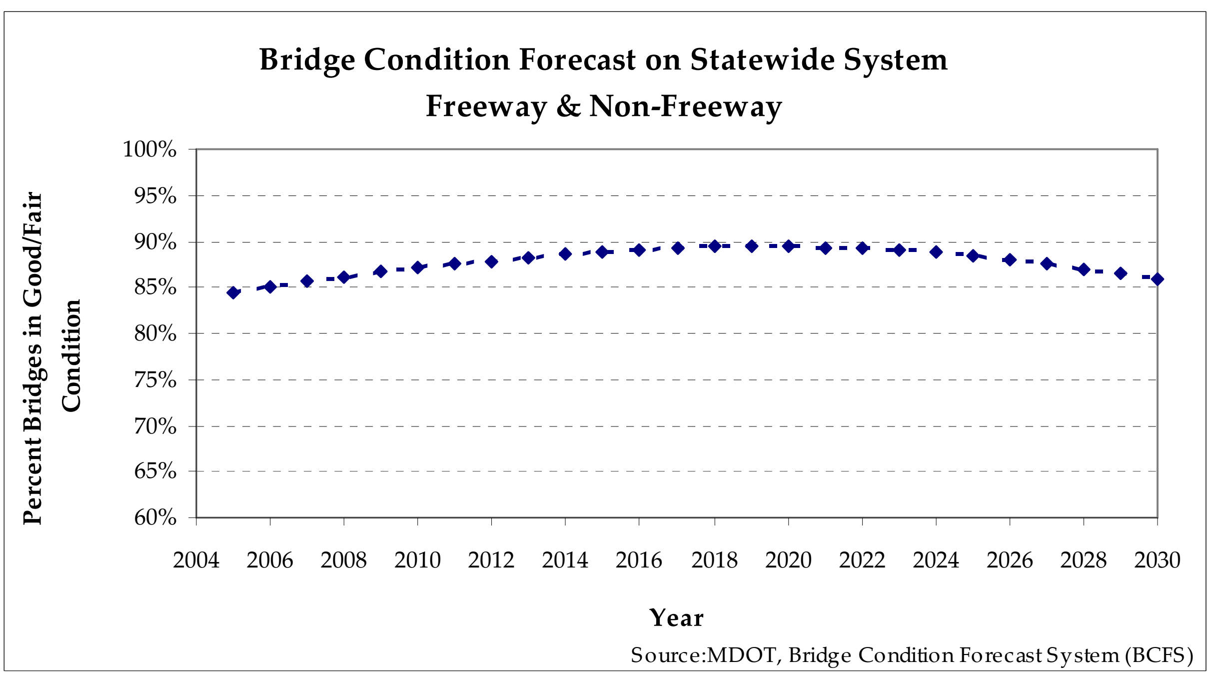
1. As a priority on the network, immediately address the needs of 100 percent of the structures of critical concern. The critical structures are those bridge needs that must be addressed immediately to preserve the safety of the public.
2. To improve the overall condition of the freeway bridge network so that 95 percent of the structures on that network are rated good or fair.
3. To improve the overall condition of the non-freeway bridge network so that 85 percent of the structures on that network are rated good or fair.

Goal number one is the department's ongoing commitment to always keep MDOT's bridges safe. Goal numbers two and three provide set targets for condition levels for the trunkline freeway and non-freeway systems. In 2004, MDOT achieved the non-freeway goal (goal number three) of 85 percent non-freeway bridges in good or fair condition. The department's strategy now is to maintain that condition, while making steady progress towards the freeway bridge goal, which the *Investment and Gap Analysis* of *MI Transportation Plan* will discuss further.

3.2.3 Highway Bridge Condition Projected Trend

Figure 20 shows the forecasted condition of trunkline bridges given current funding levels. It can be seen that given the current bridge strategy and funding, the department will continue to be able to improve the condition of the trunkline bridge network, but inflation will gradually erode the ability to make progress; after 2019, the condition of the trunkline bridges will begin to decline.

Figure 20: Long-Term Forecast: Bridge Condition on Statewide System (Combined Freeway and Non-Freeway)



A review of the freeway bridge forecast, **Figure 21**, shows that MDOT is not on track to meet the freeway bridge goal of 95 percent in good or fair condition. At this funding level, conditions will peak at approximately 90 percent of freeway bridges in good or fair condition in 2018 and thereafter freeway bridge conditions will once again decrease. **Figure 22** shows that, with current funding, MDOT will be able to exceed the non-freeway bridge goal until 2014, and then it too will begin to decline, with non-freeway bridge conditions falling below the goal of 85 percent rated good or fair by 2024.

Figure 21: Long-Term Forecast: Bridge Condition on Freeway Network

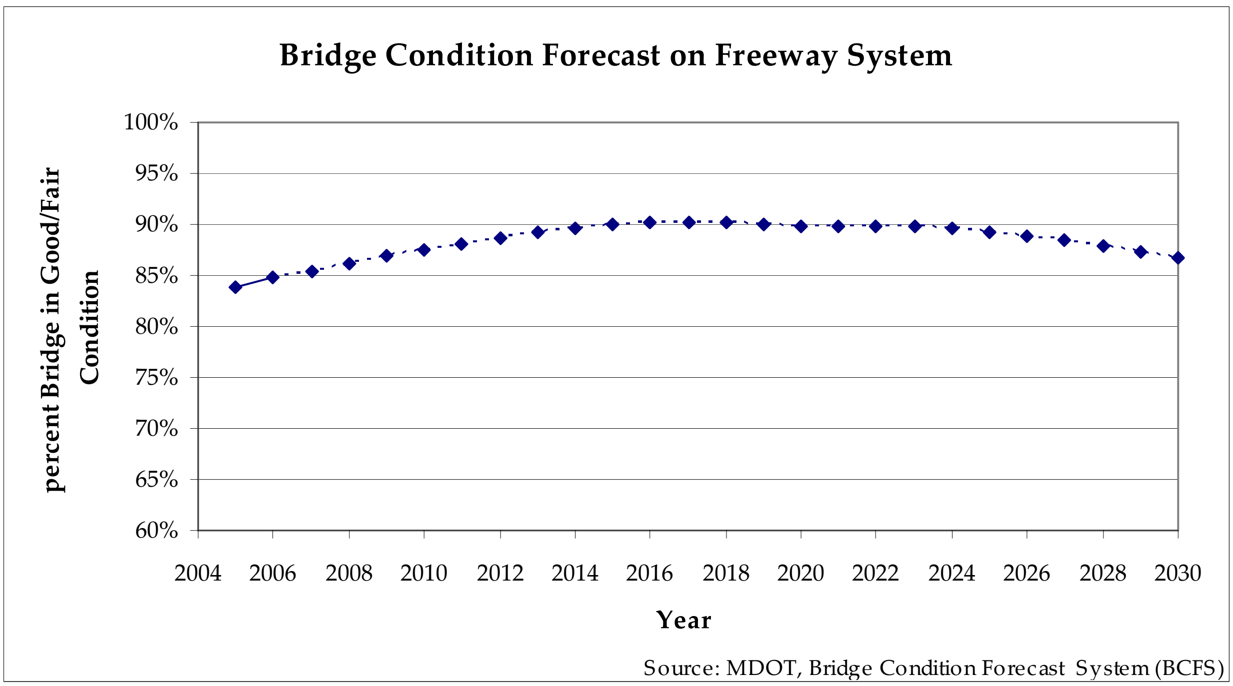
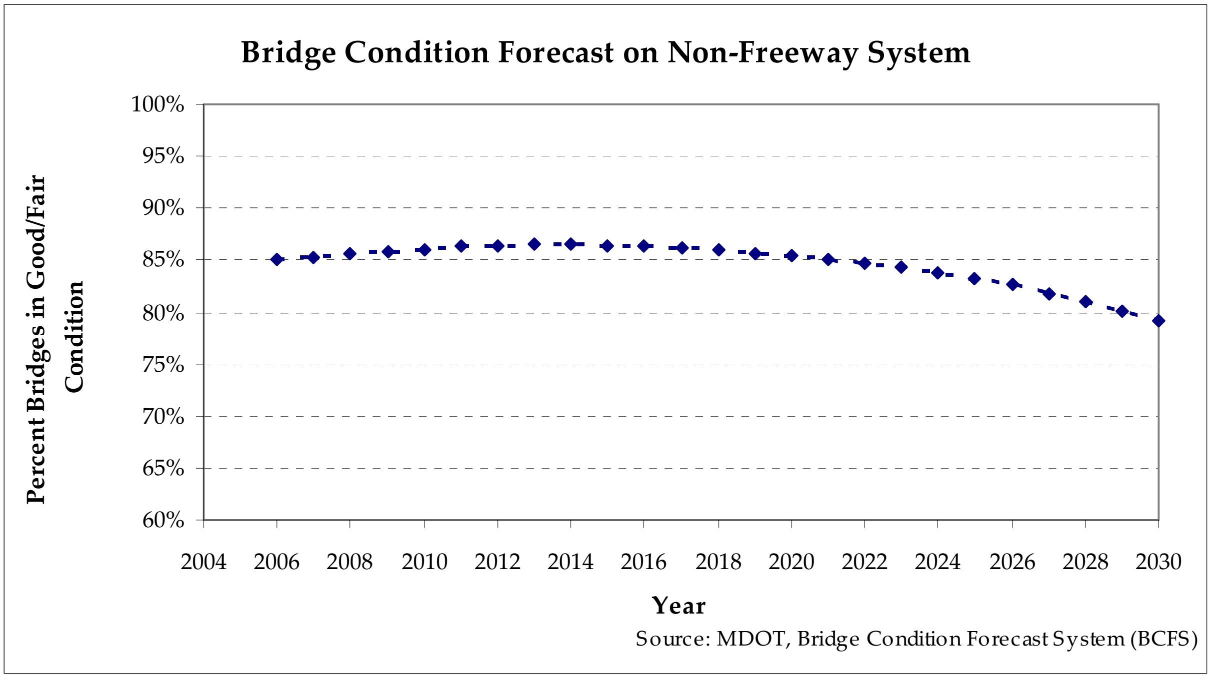


Figure 22: Long-Term Forecast: Bridge Condition on Non-Freeway Network



3.3 Highway Non-pavement Infrastructure Condition Goals and Trends

The non-pavement infrastructure is an important part of MDOT's trunkline system. It includes CPLs, rest areas, weigh stations, drainage, and other infrastructures that can impact MDOT's system performance. This section will address the characteristics, standards, and performance measures for some of the non-pavement infrastructure and their goals.

3.3.1 Carpool Parking Lots

3.3.1.1 Preservation Target Goals

Based on the statewide analysis of facility needs, the regions compiled a roster of preservation projects for each fiscal year, constrained to their preservation targets, to improve existing CPL facilities. The preservation projects are designed to meet the five goals of the carpool lot program. These goals are:

a. Improving lot surface condition to good;

b. Lot rehabilitation;

c. Maintaining and increasing usage of facilities;

d. Minor expansion of system as needed; and

e. Provide appropriate signage.

3.3.1.2 Improve and Expand (I/E) Program Statewide Goals

Projects eligible for improve-and-expand (I/E) funds include: expanding an existing lot, constructing a new lot, and acquiring property for future lot construction or existing lot expansion. Expansion projects were reviewed on a statewide level based on achieving system goals, project types, locations, and estimated costs for all such projects submitted. The goals for the carpool lot I/E program are:

- Expansion of the system;
- ROW acquisition; and
- Adding capacity in high-priority corridors.

3.3.2 Rest Areas

Currently, there are 37 rest areas/welcome centers having 500,000 or more visits each year[9]. At the end of 2007, 74 percent of those will be of the current design and will be considered in good condition. At the end of the current five-year plan, in 2010, the anticipated improvements increase that number to 94 percent of the facilities being considered in good condition. It is the goal of the Roadside Development Program to have 90 percent of its facilities with 500,000 or more visitations to be in good condition. The goal is to have a minimum of 80 percent of rest area facilities in each region to be in good condition. In order to achieve this, the Roadside Development Program needs to secure funding to accelerate the facility replacement schedule and continue to upgrade facilities and provide new facilities to meet current design standards.

The following information highlights several goals of the Roadside Development Program for rest areas:

- Buildings: Provide safe, aesthetically pleasing rest area facilities that allows access to everyone.
- Utility Systems: Connect into municipal sewage systems and water systems where feasible, and to upgrade those facilities that do not meet current health and safety guidelines.
- Increase efficient program administration and adhere to department project guidelines. Adhere to schedules and goals of the overall MDOT program, and to become an important and integral part of the mainline road and bridge program.
- Continue to expand rest area service to the Upper Peninsula, northern Lower Peninsula, and thumb areas. Continue conversion of current rustic sites into modern sites. The facility spacing guidelines would remain at a 100-mile minimum spacing.
- Replace overgrown landscaping with new planting plans that are aesthetically pleasing, use more native and naturalized plant material, and are easier to maintain. Replace existing foundation landscaping with new plant material to reduce maintenance and enhance facility aesthetics.

[9] Source: Executive Summary, *Rest Area Strategic Plan Update* – 2002

3.3.3 Drainage

The condition of MDOT's drainage and storm water systems vary widely across the state. Much of the drainage system is nearing the end of its design life and is in need of replacement or repair. Because there is not yet a complete inventory of these system components, identification and prioritization of specific replacement/repair needs is difficult. At this time, these systems are evaluated and improvements implemented as part of road and bridge construction and repair projects. In addition, new storm water control elements are added to the system where specific storm water management problems are identified. The storm water management program includes a goal of identification of all structural storm water control systems and implementation of inspection, repair, and maintenance procedures for these systems within the next five years.

3.3.4 Weigh Stations

MDOT and MSP/MCD are in agreement that Michigan needs a more efficient and effective truck weight and safety enforcement strategy. MDOT and MSP/MCD have been engaged in formal meetings to develop strategies to achieve this goal. A joint MDOT/MSP/MCD Commercial Vehicle Strategy Team has been established to analyze current methods and develop a strategy for the future.

Until the team completes its analysis, MDOT continues to follow the last agreement with MSP/MCD (May 2000) which supports a shift away from weigh station operations with more focus on mobile patrol. The Federal Motor Carrier Safety Administration is also shifting focus on vehicle inspections away from vehicles to commercial drivers and is encouraging mobile patrols.

3.3.5 Non-Motorized Facilities

The creation of a non-motorized transportation system that can supplement the existing motorized system and provide a facility for alternative modes of transportation is the ultimate non-motorized goal. This is being accomplished by:

- Providing connectivity between local and regional networks through the provision of different types of facilities (both on-road and off-road);
- Promoting the safety of the non-motorized facility users; and
- Creating convenient access to non-motorized facilities.

Chapter 4. System Performance

In this section, information from MDOT's count databases, crash data, Geographic Information System (GIS) files, and the statewide travel model is used to identify key goals and existing and projected highway performance within the following categories:

- Mobility performance;
- Connectivity among trade centers and intermodal facilities;
- Non-pavement infrastructures; and
- Special technology deployment.

4.1 Mobility Performance

This section uses 1995, 2004, 2015, and 2030 miles of roadway, annual vehicle miles traveled (VMT), and annual commercial vehicle miles traveled (CVMT) on the trunkline system to examine how Michigan roadways have met, and will continue to meet the needs of their users. In this section, each side of a divided roadway is treated separately (pavement miles) since each side can perform differently, so the total miles of roadway, VMT, and CVMT may not match those stated in previous sections of this and other technical reports.

One measure of comparison for this section will be Level of Service (LOS). LOS is a quality measure using a letter rating scale from A to F, where LOS A represents the best operating conditions and LOS F the worst. LOS ratings are defined as:

- LOS A: Free flow operations.
- LOS B: Reasonably free flow.
- LOS C: Provides for free flow with speeds still at or near free flow. Maneuvering within traffic stream is noticeably restricted.
- LOS D: Level at which speeds decline slightly, density begins to increase.
- LOS E: Describes operations at capacity. Operations are volatile due to no usable gaps in the traffic stream.
- LOS F: Breakdown in vehicular flow. Volume exceeds capacity.

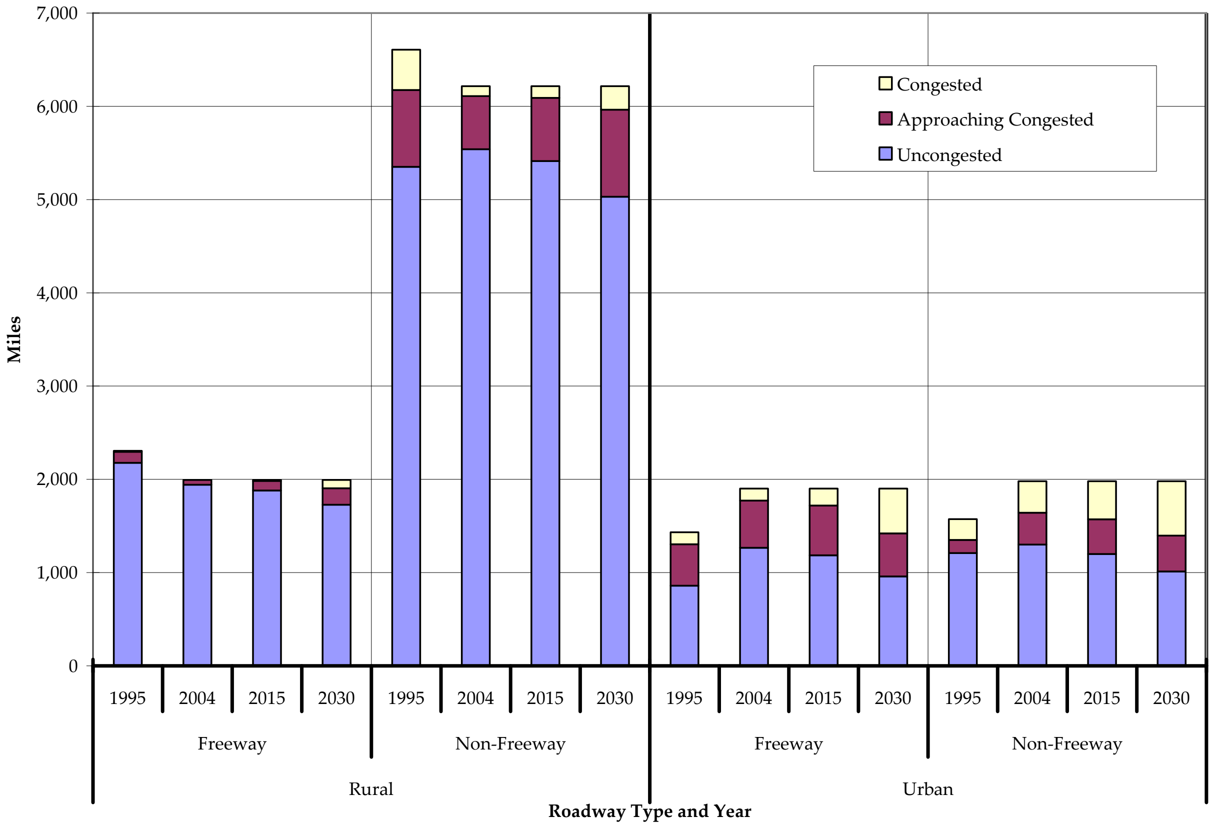
LOS is determined by using the Transportation Research Board – *Highway Capacity Manual 2000*. To determine LOS, factors such as number of vehicles, speed, road type, lane width, shoulder widths, passing/no-passing zone, and other road features are examined.

For this section roadway congestion is described in three categories: (1) uncongested, (2) approaching congested, and (3) congested. Uncongested are all LOS A – C for non-freeway and freeway; approaching congested are LOS D for non-freeway and LOS D - E for freeway; congested are LOS E - F for non-freeway and LOS F for freeway.

4.1.1 Trends in Miles, VMT, and CVMT by Roadway Type

Figure 23 illustrates the miles of roads in the trunkline system by roadway type. Between 1995 and 2004, there are increases in urban roadway miles with decreases in rural miles. The main reason for this change is that between 1995 and 2004, the number and size of the urban areas increased due to the 2000 Census. Roadway miles for 2015 and 2030 are considered identical to 2004.

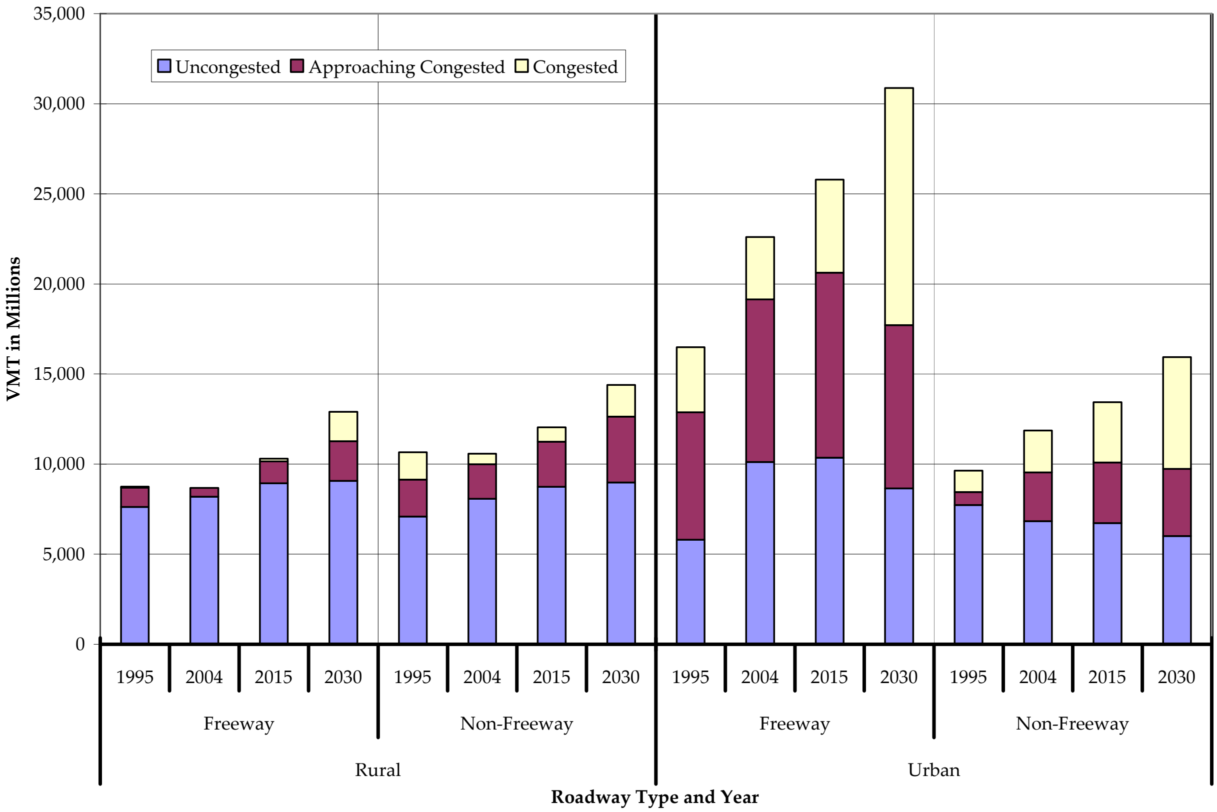
Figure 23: Miles by Roadway Type



Source: Michigan Department of Transportation, Congestion Management System and Statewide Travel Demand Model

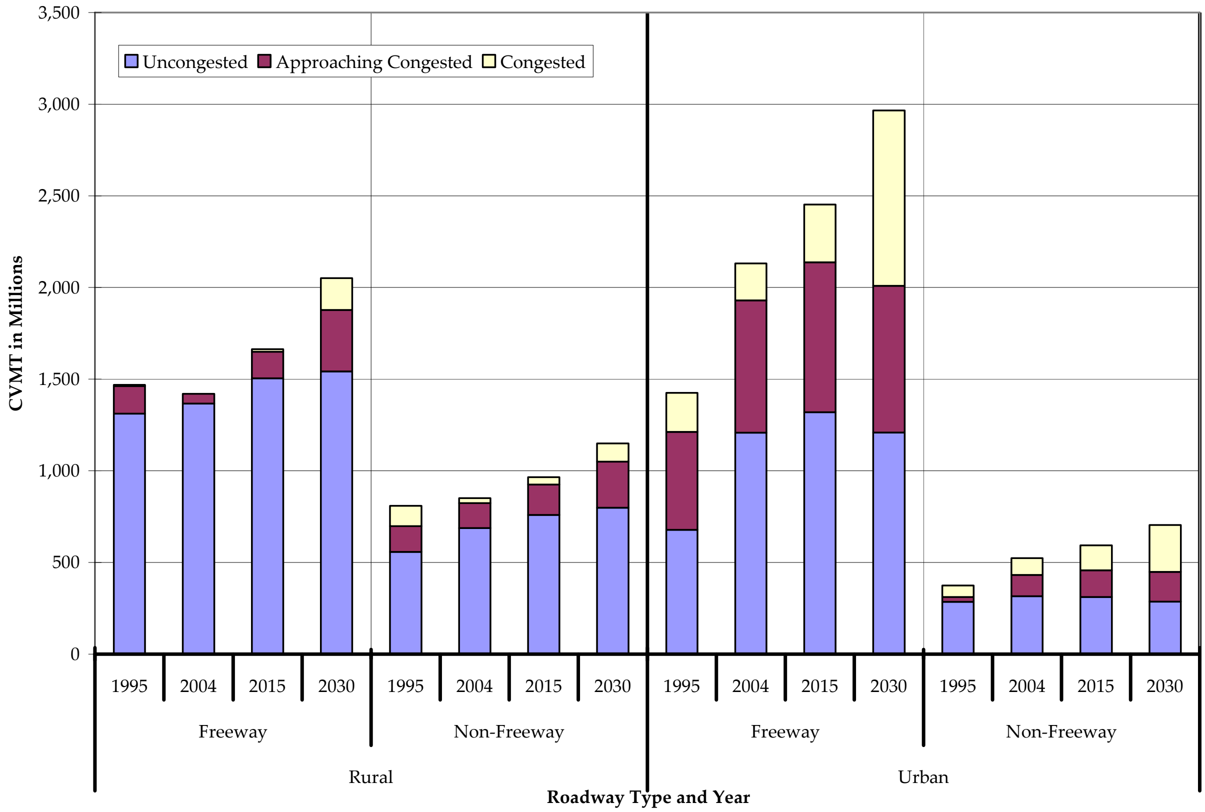
Figure 24 and **Figure 25** show that overall VMT and CVMT increases with time. The only exception is for the rural freeway between 1995 and 2004. This is due to the reclassification of approximately 600 miles of rural roads to urban roads in this period, which obscures the picture of traffic growth.

Figure 24: Average Annual VMT by Roadway Type



Source: Michigan Department of Transportation, Congestion Management System and Statewide Travel Demand Model

Figure 25: Average Annual Commercial VMT by Roadway Type



Source: Michigan Department of Transportation, Congestion Management System and Statewide Travel Demand Model

4.1.2 Trends in Congested vs. Uncongested Roads

This section compares miles, annual VMT, and annual CVMT by roadway type and uncongested, approaching congested, and congested, for 1995, 2004, 2015, and 2030. **Table 15, Figure 23**Figure 23**, Figure 24,** and **Figure 25** show that for the trunkline system in 1995:

- Seven percent of the miles were congested and 13 percent of the miles were approaching congested, accounting for 20 percent of the mileage at or approaching congested.
- Fourteen percent of the VMT was congested and 25 percent of the VMT was approaching congested, accounting for 39 percent of the VMT at or approaching congested.
- Ten percent of the CVMT was congested and 21 percent of the CVMT was approaching congested, accounting for 31 percent of the CVMT at or approaching congested.
- While only 20 percent of the mileage was at or approaching congested, 39 percent of the VMT and 31 percent of CVMT were traveling on these roads.

- Twenty-five percent of the miles were urban, but the urban roads account for 57 percent of the total VMT and 44 percent of the total CVMT.

Table 15: 1995 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*% Total*	*VMT in Millions*	*% Total*	*CVMT in Millions*	*% Total*
Rural	Freeway	Uncongested	2,177	18%	7,623	17%	1,311	32%
		Approaching Congested	119	1%	1,065	2%	151	4%
		Congested	8	0%	67	0%	7	0%
		Subtotal	2,305	19%	8,755	19%	1,469	36%
	Non-Freeway	Uncongested	5,352	45%	7,091	16%	557	14%
		Approaching Congested	823	7%	2,054	5%	141	3%
		Congested	433	4%	1,510	3%	111	3%
		Subtotal	6,608	55%	10,655	23%	808	20%
		Rural Subtotal	8,913	75%	19,410	43%	2,278	56%
Urban	Freeway	Uncongested	860	7%	5,808	13%	677	17%
		Approaching Congested	444	4%	7,069	16%	535	13%
		Congested	128	1%	3,608	8%	213	5%
		Subtotal	1,432	12%	16,486	36%	1,425	35%
	Non-Freeway	Uncongested	1,210	10%	7,734	17%	286	7%
		Approaching Congested	139	1%	716	2%	25	1%
		Congested	225	2%	1,184	3%	64	2%
		Subtotal	1,573	13%	9,633	21%	375	9%
		Urban Subtotal	3,005	25%	26,119	57%	1,800	44%
		Total	11,918		45,529		4,078	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: MDOT Congestion Management System

Table 16, Figure 23 and **Figure 24** show that for the trunkline system in 2004:

- Five percent of the miles were congested and 12 percent of the miles were approaching congested, accounting for 17 percent of the mileage at or approaching congested (a three percent reduction from 1995).
- Eleven percent of the VMT was congested and 27 percent of the VMT was approaching congested, accounting for 38 percent of the VMT at or approaching congested (a one percent reduction from 1995).
- Seven percent of the CVMT was congested and 21 percent of the CVMT was approaching congested, accounting for 28 percent of the CVMT at or approaching congested (three percent reduction from 1995).
- While only 17 percent of the mileage was at or approaching congested, 38 percent of the VMT and 28 percent of the CVMT were traveling on these roads.
- Thirty-two percent of the miles were urban but the urban roads accounted for 64 percent of the total VMT and 54 percent of the total CVMT, accounting for a seven percent growth in miles, seven percent growth in VMT and ten percent growth in CVMT.
- From 1995 to 2004 there was a 28 percent reduction in congested miles, with less than one percent growth in congested VMT and an 18 percent reduction in congested CVMT.
- From 1995 to 2004 there was a four-percent reduction in miles approaching congested, but a 30 percent increase in VMT and a 20 percent increase in CVMT approaching congested. While there are less miles of roadway approaching congested these roads see increases in VMT and CVMT.
- From 1995 to 2004 there is a 29 percent growth in urban miles, 32 percent growth in urban VMT and a 48 percent growth in urban CVMT. This illustrates that, not only is Michigan getting more urban, but the urban areas are representing a larger part of the overall travel in Michigan.

This again illustrates the effects of the reclassification of approximately 600 miles of rural roads to urban roads in this period as well as an update to the highway capacity manual methodology which obscures the picture of traffic growth.

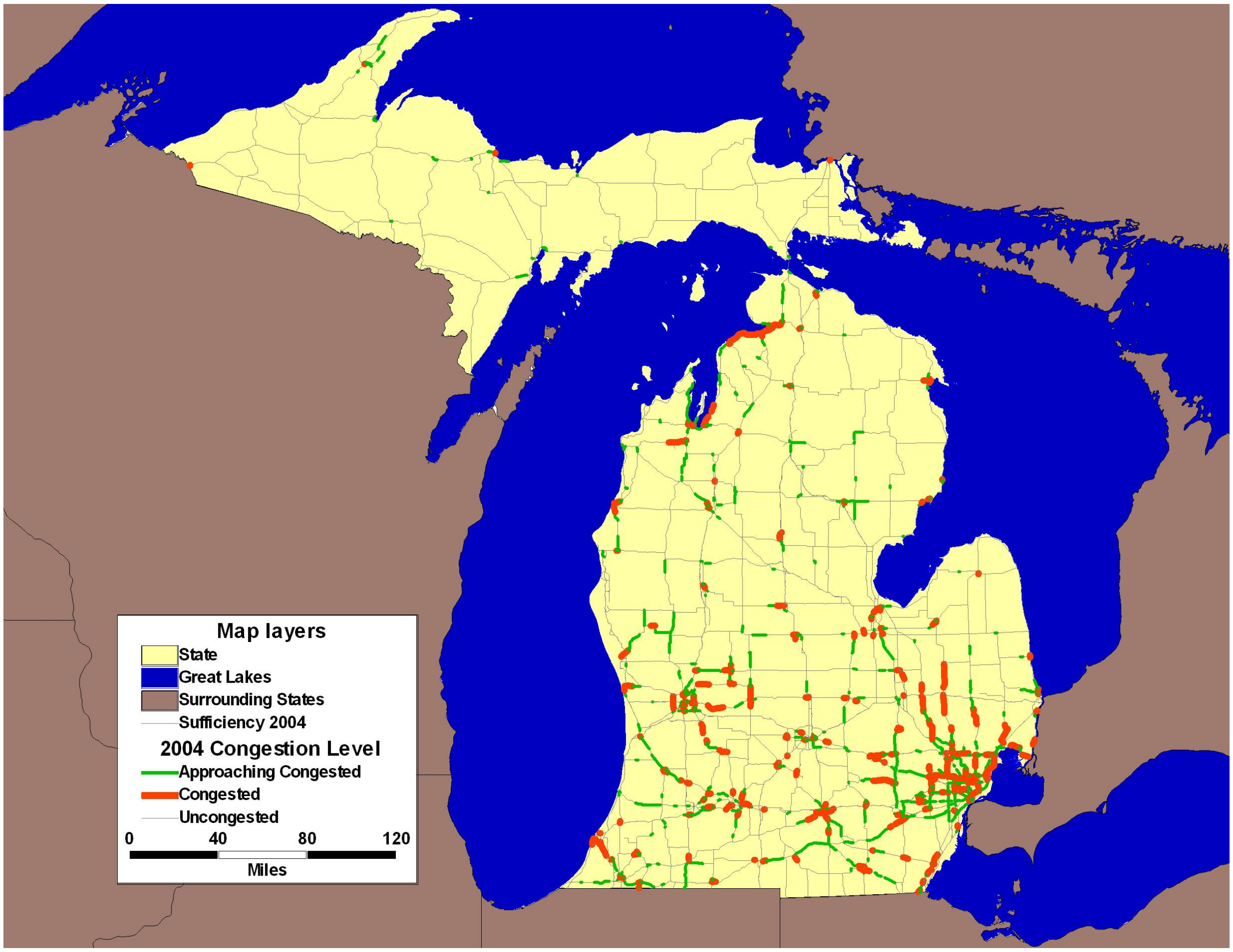
Table 16: 2004 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*%Total*	*VMT in Millions*	*%Total*	*CVMT in Millions*	*%Total*
Rural	Freeway	Uncongested	1,941	16%	8,196	15%	1,367	28%
		Approaching Congested	52	0%	489	1%	53	1%
		Congested	0	0%	0	0%	0	0%
		Subtotal	1,993	16%	8,685	16%	1,420	29%
	Non-Freeway	Uncongested	5,539	46%	8,069	15%	688	14%
		Approaching Congested	570	5%	1,920	4%	135	3%
		Congested	106	1%	591	1%	28	1%
		Subtotal	6,215	51%	10,579	20%	851	17%
		Rural Subtotal	8,208	68%	19,264	36%	2,272	46%
Urban	Freeway	Uncongested	1,266	10%	10,114	19%	1,208	25%
		Approaching Congested	506	4%	9,032	17%	722	15%
		Congested	129	1%	3,464	6%	202	4%
		Subtotal	1,901	16%	22,610	42%	2,132	43%
	Non-Freeway	Uncongested	1,301	11%	6,832	13%	317	6%
		Approaching Congested	339	3%	2,710	5%	116	2%
		Congested	338	3%	2,325	4%	92	2%
		Subtotal	1,978	16%	11,867	22%	524	11%
		Urban Subtotal	3,879	32%	34,476	64%	2,656	54%
		Total	12,087		53,741		4,927	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: MDOT Congestion Management System

Figure 26: 2004 Congestion Levels



Source: Michigan Department of Transportation, Statewide Travel Demand Model

Figure 26 illustrates the location of the 2004 congested and approaching congested roadways. It can be seen that the congested and approaching congested roadways are primarily in urban areas or the areas surrounding urban areas.

Table 17, Figure 23, Figure 24, and **Figure 25** show that for the current trunkline system in 2015:

- Six percent of the miles are projected to be congested and 14 percent of the miles are projected to be approaching congested, accounting for 20 percent of the mileage at or approaching congested (a three percent increase from 2004).
- Fourteen percent of the VMT is projected to be congested and 28 percent of the VMT is projected to be approaching congested, accounting for 42 percent of the VMT at or approaching congested (a four percent increase from 2004).
- Nine percent of the CVMT is projected to be congested and 23 percent of the CVMT will be approaching congested, accounting for 32 percent of the CVMT at or approaching congested (a four percent increase from 2004).
- While only 20 percent of the mileage is projected to be at or approaching congested 42 percent of the VMT and 32 percent of the CVMT were traveling on these roads.
- Thirty-two percent of the miles (based on the 2004 urban areas) are urban and account for 64 percent of the total VMT and 54 percent of the total CVMT.
- From 2004 to 2015 there is a 26 percent increase in congested miles, 48 percent increase in congested VMT, and 57 percent increase in congested CVMT.
- From 2004 to 2015 there is a 15 percent increase in miles approaching congested, 23 percent increase for VMT approaching congested, and 24 percent increase for CVMT approaching congested.
- From 2004 to 2015 there is no growth in urban miles (since this was based on the 2004 urban areas), but a 14 percent growth in urban VMT and 15 percent growth in urban CVMT.

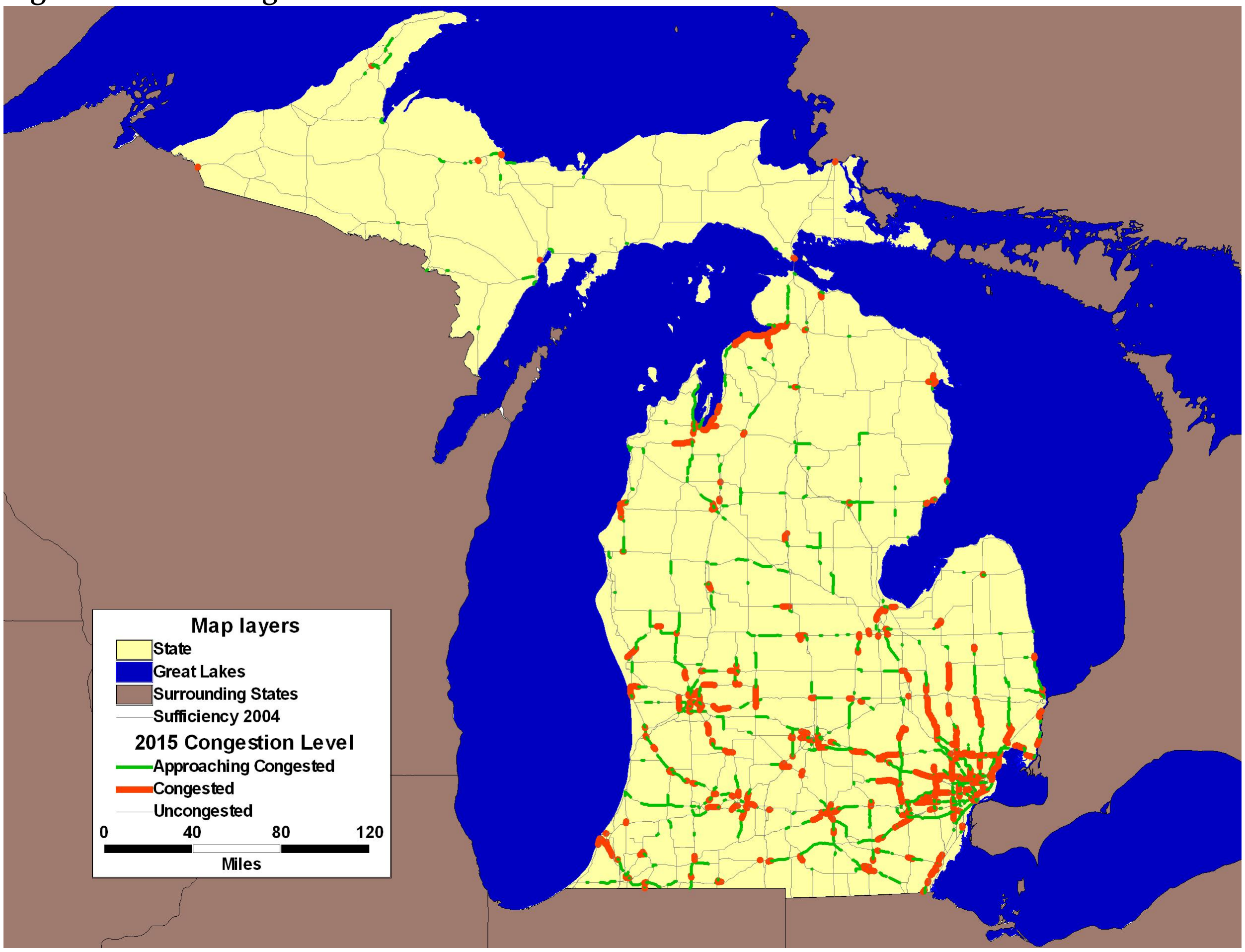
Table 17: 2015 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*%Total*	*VMT in Millions*	*%Total*	*CVMT in Millions*	*%Total*
Rural	Freeway	Uncongested	1,880	16%	8,937	15%	1,505	27%
		Approaching Congested	104	1%	1,209	2%	144	3%
		Congested	9	0%	161	0%	14	0%
		Subtotal	1,993	16%	10,308	17%	1,663	29%
	Non-Freeway	Uncongested	5,413	45%	8,737	14%	759	13%
		Approaching Congested	680	6%	2,505	4%	166	3%
		Congested	123	1%	805	1%	41	1%
		Subtotal	6,215	51%	12,047	20%	966	17%
		Rural Subtotal	8,208	68%	22,355	36%	2,629	46%
Urban	Freeway	Uncongested	1,186	10%	10,353	17%	1,320	23%
		Approaching Congested	533	4%	10,276	17%	818	14%
		Congested	182	2%	5,159	8%	315	6%
		Subtotal	1,901	16%	25,788	42%	2,452	43%
	Non-Freeway	Uncongested	1,198	10%	6,723	11%	312	5%
		Approaching Congested	371	3%	3,367	5%	146	3%
		Congested	409	3%	3,345	5%	136	2%
		Subtotal	1,978	16%	13,435	22%	593	10%
		Urban Subtotal	3,879	32%	39,222	64%	3,046	54%
		Total	12,087		61,578		5,675	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: MDOT Congestion Management System & Statewide Travel Demand Model

Figure 27: 2015 Congestion Levels



Source: Michigan Department of Transportation, Statewide Travel Demand Model

Figure 27 illustrates the location of the 2015 congested and approaching congested roadways. It can be seen that the congested and approaching congested roadways are primarily in urban areas or the areas surrounding urban areas; however, roadways connecting urban areas to each other are also starting to have increases. Some rural roadways are approaching congested.

Table 18, Figure 23, Figure 24, and **Figure 25** show that for the current trunkline system in 2030:

- Twelve percent of the miles are projected to be congested and 16 percent of the miles are projected to be approaching congested, accounting for 28 percent of the mileage at or approaching congested (an 11 percent increase from 2004).
- Thirty percent of the VMT is projected to be congested and 25 percent of the VMT is projected to be approaching congested, accounting for 55 percent of the VMT at or approaching congested (a 17 percent increase from 2004).
- Twenty-two percent of CVMT is projected to be congested and 23 percent of the CVMT will be approaching congested, accounting for 45 percent of the CVMT at or approaching congested (a 17 percent increase from 2004).
- While 28 percent of the mileage is projected to be at or approaching congested 55 of the VMT and 45 percent of the CVMT is traveling these roads.
- Thirty-two percent of the miles (based on the 2004 urban areas) are urban and account for 63 percent of the total VMT and 53 percent of the total CVMT. By 2030 we start to see larger increases in travel in the rural areas shown by the one-percent reduction in both VMT and CVMT in the urban areas.
- From 2004 to 2030 there is projected to be a 145 percent increase in congested miles, 257-percent increase in congested VMT, and 361 percent increase in congested CVMT.
- From 2004 to 2030 there is projected to be a 34 percent increase in miles approaching congested, a 32-percent increase for VMT approaching congested, and a 51 percent increase of CVMT approaching congested.
- From 2004 to 2030 there is no growth in urban miles (since this was based in the 2004 urban areas), but a projected 36-percent increase in urban VMT and a 38-percent increase in urban CVMT.

In general, between 2004 and 2030 increases in VMT, CVMT, congested miles, congested VMT, and congested CVMT are projected and will place a heavy burden on the trunkline system.

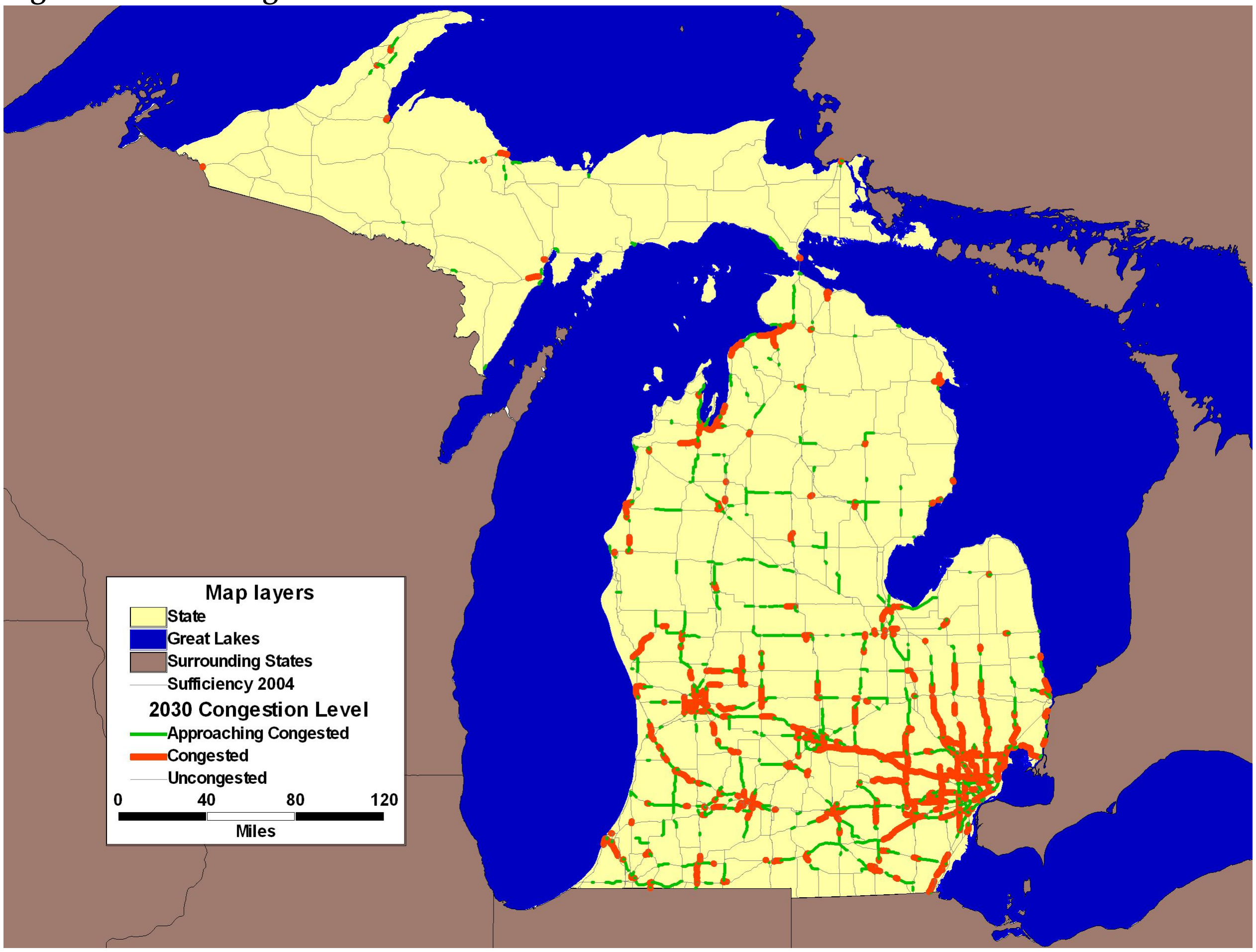
Table 18: 2030 Miles, Annual Vehicle Miles Traveled (AVMT), Annual Commercial Vehicle Miles Traveled (ACVMT) on State Trunkline System

	System	*Level of Service*	*Miles*	*%Total*	*VMT in Millions*	*%Total*	*CVMT in Millions*	*%Total*
Rural	Freeway	Uncongested	1,728	14%	9,065	12%	1,541	22%
		Approaching Congested	176	1%	2,202	3%	336	5%
		Congested	90	1%	1,638	2%	174	3%
		Subtotal	1,993	16%	12,905	17%	2,051	30%
	Non-Freeway	Uncongested	5,031	42%	8,984	12%	798	12%
		Approaching Congested	934	8%	3,658	5%	253	4%
		Congested	250	2%	1,753	2%	99	1%
		Subtotal	6,215	51%	14,396	19%	1,149	17%
		Rural Subtotal	8,208	68%	27,301	37%	3,201	47%
Urban	Freeway	Uncongested	957	8%	8,656	12%	1,209	18%
		Approaching Congested	464	4%	9,054	12%	801	12%
		Congested	480	4%	13,163	18%	956	14%
		Subtotal	1,901	16%	30,872	42%	2,966	43%
	Non-Freeway	Uncongested	1,011	8%	6,006	8%	286	4%
		Approaching Congested	386	3%	3,725	5%	163	2%
		Congested	581	5%	6,213	8%	255	4%
		Subtotal	1,978	16%	15,944	22%	704	10%
		Urban Subtotal	3,879	32%	46,816	63%	3,670	53%
		Total	12,087		74,117		6,870	

	Freeway	Non-Freeway
Uncongested	LOS A-C	LOS A-C
Approaching Congested	LOS D-E	LOS D
Congested	LOS F	LOS E-F

Source: MDOT Congestion Management System & Statewide Travel Demand Model

Figure 28: 2030 Congestion Level



Source: Michigan Department of Transportation, Statewide Travel Demand Model

Figure 28 illustrates the location of the 2030 congested and approaching congested roadways. It can be seen that urban areas now are mostly congested and the roadways connecting urban areas to each other are now congested as well. Some rural roadways are approaching congested.

4.1.3 Congestion Duration

The previous section examined levels of congestion as defined in the *Highway Capacity Manual 2000*, which uses the 30th highest hour (HH) of traffic to define whether or not a section of road is congested. The following analysis looks at the LOS at each of the following hours: 30th, 50th, 100th, 200th, 500th, 700th, and 1000th highest hours for 2005, 2015, and 2030, in miles, to determine how long the congestion lasts and in turn reveal how the system operates. When reviewing this analysis, it is important to remember that one year consists of 8760 hours (24 hours/day * 365 days/year = 8760 hours/year). **Table 19** illustrates the percent of each hour examined to the total hours in a year.

Table 19: Percent of Total Hours Represented by Highest Hours

30 HH	*50 HH*	*100 HH*	*200 HH*	*500 HH*	*700 HH*	*1000 HH*
0.3%	0.6%	1.1%	2.2%	5.7%	8.0%	11.4%

This concept will be further examined by the following example. Assume that the highest traffic volumes on a roadway all come in the weekday peak hours and that the peak hours are two hours long. The lowest peak hour volume in the year would represent the 520th HH (2 hours/day * 5 days/week * 52 weeks/ year = 520th Highest Hour).

4.1.3.1 Trunkline System Miles

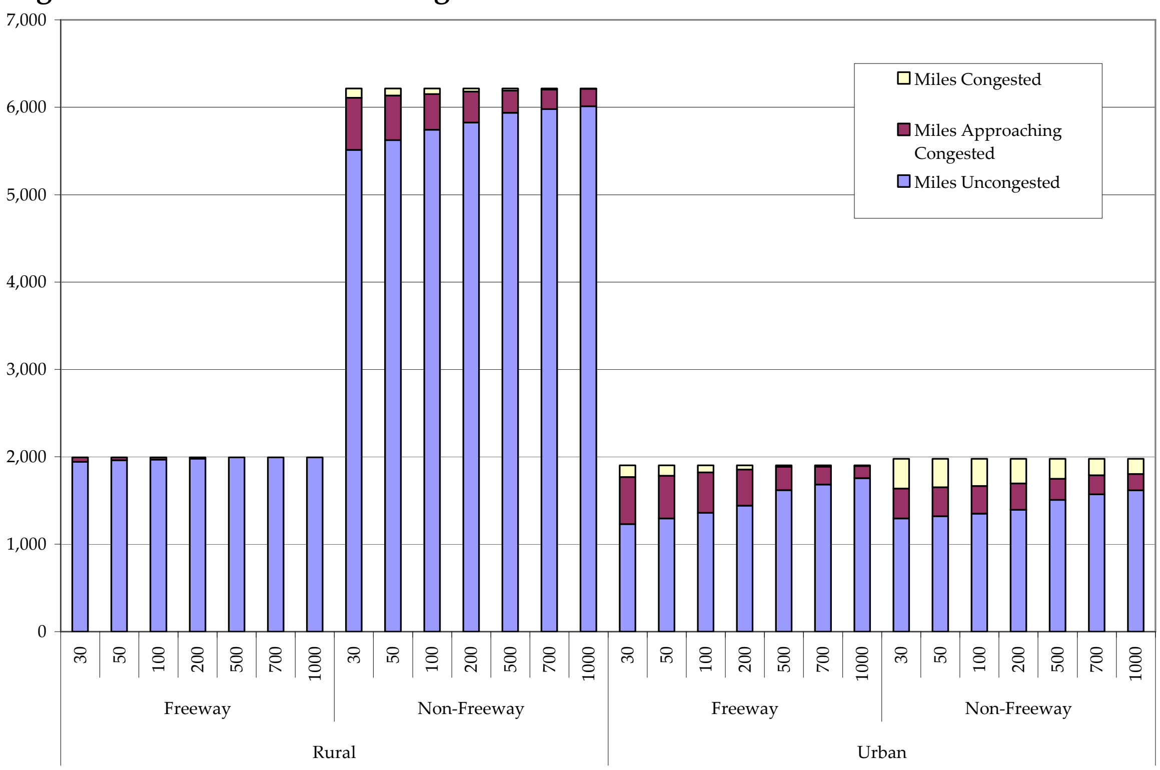
Table 20, Table 21, and **Table 22,** as well as **Figure 29, Figure 30, Figure 31**, and **Figure 32** show the miles of uncongested, approaching congested, and congested roadway by type of road and HH for 2005, 2015, and 2030. It can be seen that from 2005 to 2030 both congested and approaching congested miles increase over time. Congested miles account for five percent of the trunkline miles in 2005 and increase to 12 percent in 2030. Approaching congested miles account for 12 percent of miles in 2005 and increase to 16 percent of the miles in 2030. Not only is congestion getting worse with time but the congested conditions are lasting longer. Looking at the 1000th HH in 2005 two percent of the miles are congested by 2030 that has increased to three percent, and in 2005 roads approaching congested account for four percent of the roads while in 2030 they account for nine percent.

Table 20: 2005 Duration of Congestion in Miles on State Trunkline System

	System	*Level of Service*	*30th*	*50th*	*100th*	*200th*	*500th*	*700th*	*1000th*
Rural	Freeway	Uncongested	1941	1961	1969	1979	1993	1993	1993
		Approaching Congested	52	32	24	14	0	0	0
		Congested	0	0	0	0	0	0	0
	Non-Freeway	Uncongested	5513	5626	5743	5826	5937	5978	6013
		Approaching Congested	598	510	408	354	256	226	198
		Congested	105	79	64	35	22	11	4
Urban	Freeway	Uncongested	1231	1295	1359	1441	1619	1681	1754
		Approaching Congested	539	488	463	413	266	207	141
		Congested	131	117	79	47	16	12	6
	Non-Freeway	Uncongested	1294	1320	1349	1395	1507	1571	1615
		Approaching Congested	344	331	317	302	240	218	186
		Congested	340	327	312	281	231	189	176
	Total Congested		577	523	455	363	269	213	186
	%of 30th		100%	91%	79%	63%	47%	37%	32%
	%of Total Miles Congested		5%	4%	4%	3%	2%	2%	2%

Source: MDOT Congestion Management System & Statewide Travel Demand Model

Figure 29: 2005 Duration of Congestion in Miles



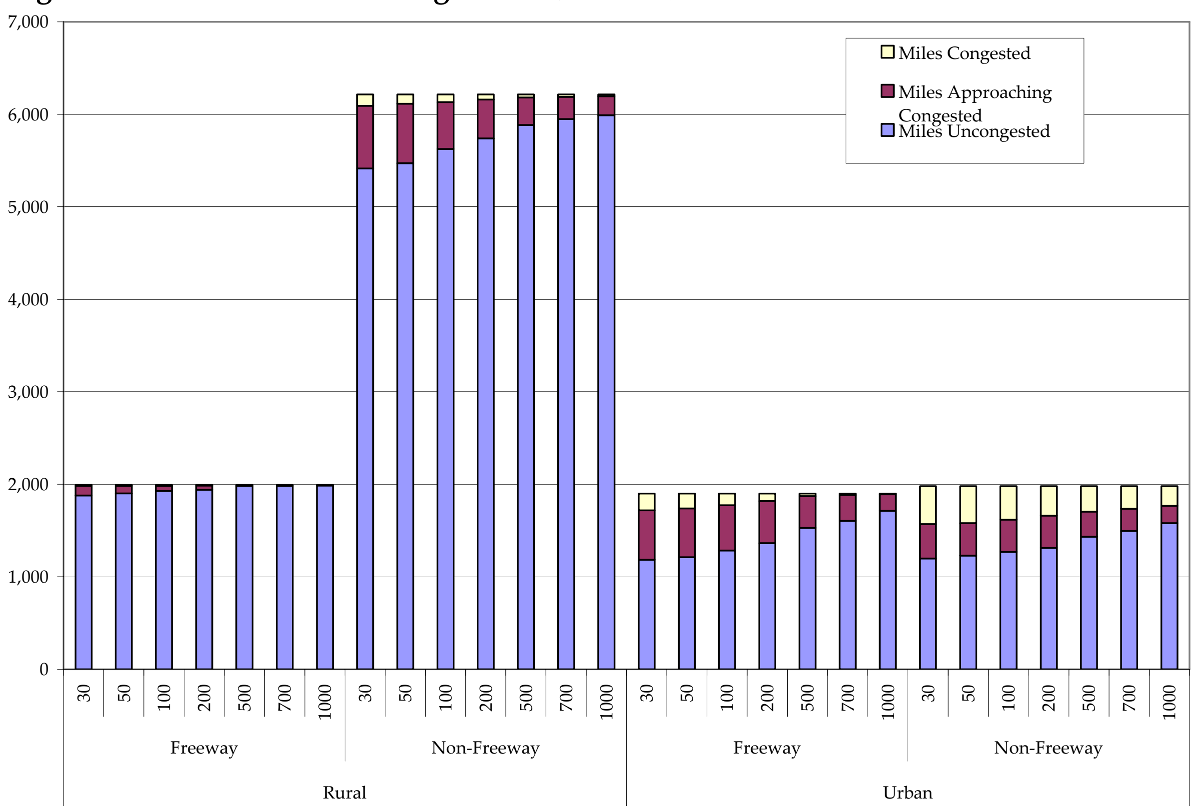
Source: Michigan Department of Transportation, Congestion Management System & Statewide Travel Demand Model

Table 21: 2015 Duration of Congestion in Miles on State Trunkline System

	System	*Level of Service*	*30th*	*50th*	*100th*	*200th*	*500th*	*700th*	*1000th*
Rural	Freeway	Uncongested	1880	1903	1928	1941	1984	1984	1986
		Approaching Congested	104	81	55	45	9	9	7
		Congested	9	9	9	7	0	0	0
	Non-Freeway	Uncongested	5413	5472	5625	5738	5886	5948	5989
		Approaching Congested	680	642	507	421	297	242	207
		Congested	123	101	83	56	32	25	20
Urban	Freeway	Uncongested	1186	1213	1285	1363	1528	1605	1713
		Approaching Congested	533	525	490	455	344	277	178
		Congested	182	162	126	83	29	18	10
	Non-Freeway	Uncongested	1198	1229	1268	1312	1434	1496	1580
		Approaching Congested	371	349	351	350	271	237	188
		Congested	409	400	360	317	273	244	211
	Total Congested		723	672	578	462	334	288	240
	%of 30th		100%	93%	80%	64%	46%	40%	33%
	%of Total Miles Congested		6%	6%	5%	4%	3%	2%	2%

Source: MDOT Congestion Management System & Statewide Travel Demand Model

Figure 30: 2015 Duration of Congestions (in miles)



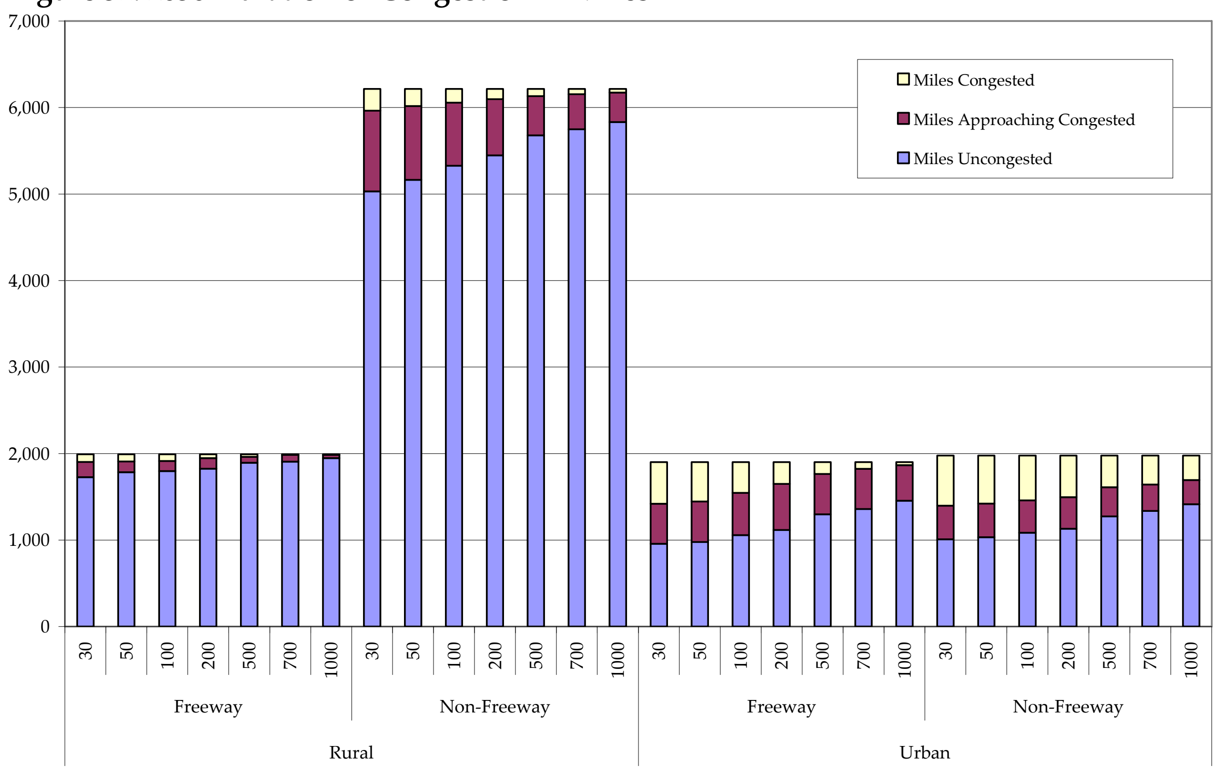
Source: Michigan Department of Transportation, Congestion Management System & Statewide Travel Demand Model

Table 22: 2030 Duration of Congestion in Miles on State Trunkline System

	System	*Level of Service*	*30th*	*50th*	*100th*	*200th*	*500th*	*700th*	*1000th*
Rural	Freeway	Uncongested	1728	1784	1798	1824	1893	1907	1946
		Approaching Congested	176	125	115	122	68	77	39
		Congested	90	84	79	46	31	9	7
	Non-Freeway	Uncongested	5031	5164	5327	5447	5678	5749	5832
		Approaching Congested	934	853	729	648	453	404	341
		Congested	250	198	159	119	84	62	42
Urban	Freeway	Uncongested	957	976	1058	1117	1299	1359	1455
		Approaching Congested	464	468	489	533	464	463	410
		Congested	480	456	354	251	137	79	36
	Non-Freeway	Uncongested	1011	1032	1087	1132	1273	1337	1416
		Approaching Congested	386	390	372	363	338	306	279
		Congested	581	557	519	483	367	335	283
	Total Congested		1,401	1,294	1,112	900	619	485	368
	%of 30th		100%	92%	79%	64%	44%	35%	26%
	%of Total Miles Congested		12%	11%	9%	7%	5%	4%	3%

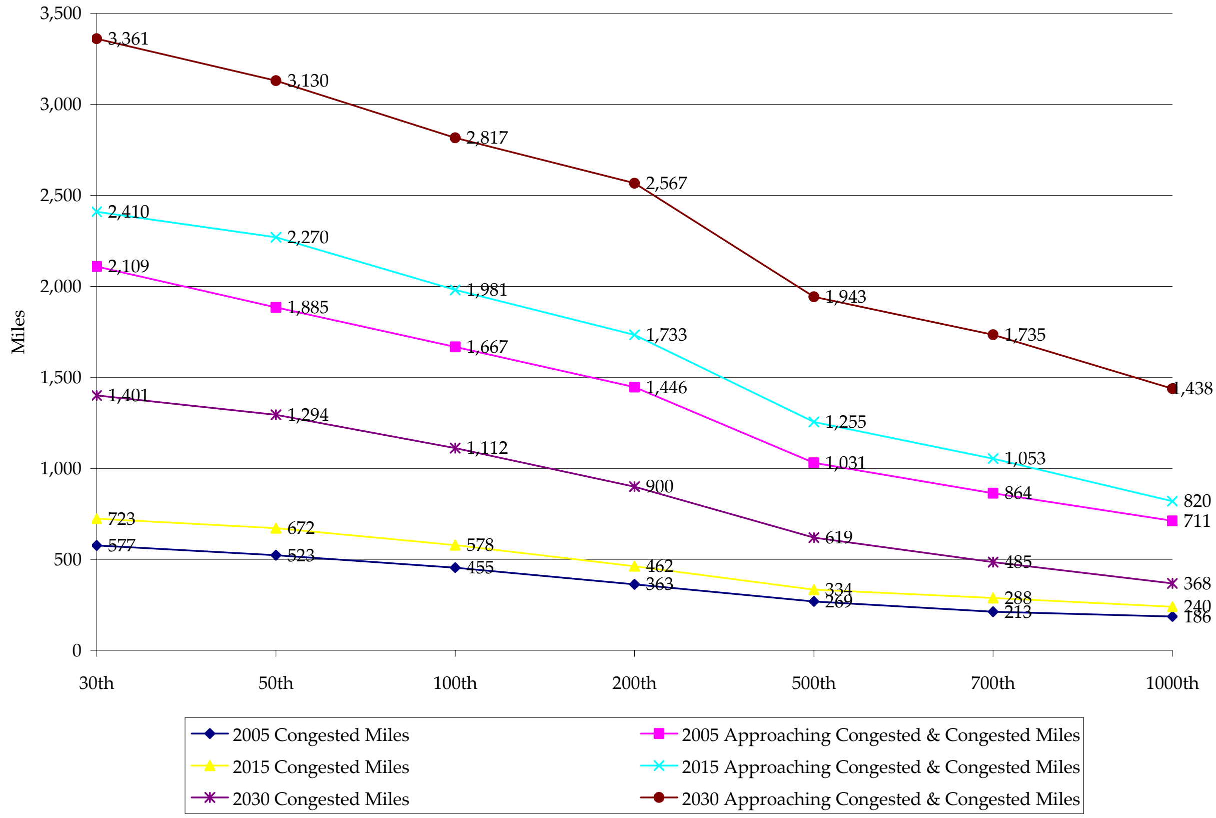
Source: MDOT Congestion Management System & Statewide Travel Demand Model

Figure 31: 2030 Duration of Congestion in Miles



Source: Michigan Department of Transportation, Congestion Management System & Statewide Travel Demand Model

Figure 32: Approaching Congested and Congested Miles by Highest Hour



Source: Michigan Department of Transportation, Congestion Management System & Statewide Travel Demand Model

4.2 Connectivity among Trade Centers and Intermodal Facilities

4.2.1 Travel Time Analysis

A travel time analysis was conducted using the statewide travel demand model. This analysis examines the systems connectivity and accessibility as it relates to the following types of facilities available across the state:

- Airports with commercial service;
- AMTRAK stations;
- Business centers (major employment centers);
- Bus stations;
- Carpool parking lots;
- Colleges;
- Hospitals;
- Intercity bus stations;
- Commercial rail junctions;
- State police posts;
- Commercial marine ports;
- Intermodal freight terminals;
- Roadside park or rest areas; and
- State parks.

This analysis only examined facilities located in Michigan, so there are areas along the border that may have better connectivity to these types of facilities than presented. This analysis used the statewide travel demand model's uncongested travel times to determine the time and distance needed to travel to these locations and then examined what percent of the population, households, and employees were within 15, 30, 60, 75, 90, and 90 or more minutes and 10, 20, 30, 40, 50, and 50 or more miles from the nearest facilities. **Table 23** illustrates the results for time and **Table 24** illustrates the results for distance.

Table 23: Time (minutes) from Facilities by 2005 Population, Households, and Employment

	2005 Population						
	15	*30*	*45*	*60*	*75*	*90*	*90+*
Air Carriers	26.67%	66.04%	85.89%	94.92%	98.54%	99.77%	100.00%
Amtrak	58.10%	78.08%	85.57%	88.33%	90.11%	91.06%	100.00%
Business Centers	84.01%	97.45%	99.02%	99.54%	99.91%	99.97%	100.00%
Bus Stations	66.85%	92.76%	98.36%	99.62%	99.90%	99.99%	100.00%
Carpool Parking Lots	74.85%	97.84%	99.57%	99.91%	99.99%	100.00%	100.00%
Colleges and Universities	68.12%	90.70%	96.66%	98.68%	99.63%	99.87%	100.00%
Hospitals	81.58%	98.72%	99.73%	99.88%	100.00%	100.00%	100.00%
Intercity Bus Terminals	44.00%	84.87%	94.33%	99.02%	99.71%	99.98%	100.00%
Railroad Junctions	72.22%	95.81%	99.08%	99.95%	100.00%	100.00%	100.00%
State Police Posts	95.93%	99.73%	99.98%	100.00%	100.00%	100.00%	100.00%
Port	33.53%	58.76%	77.78%	87.46%	94.77%	99.35%	100.00%
Intermodal Freight Facilities	20.15%	36.96%	44.77%	50.75%	56.70%	62.16%	100.00%
Roadside Parks	51.66%	97.86%	99.91%	100.00%	100.00%	100.00%	100.00%
State Parks	32.91%	90.21%	99.60%	99.98%	100.00%	100.00%	100.00%

	2005 Households						
	15	*30*	*45*	*60*	*75*	*90*	*90+*
Air Carriers	27.35%	67.24%	86.24%	94.97%	98.51%	99.77%	100.00%
Amtrak	59.15%	78.51%	85.65%	88.26%	89.94%	90.89%	100.00%
Business Centers	84.63%	97.38%	98.98%	99.52%	99.90%	99.97%	100.00%
Bus Stations	67.90%	93.13%	98.40%	99.62%	99.90%	99.99%	100.00%
Carpool Parking Lots	74.63%	97.80%	99.55%	99.91%	99.99%	100.00%	100.00%
Colleges and Universities	69.53%	90.87%	96.59%	98.62%	99.61%	99.86%	100.00%
Hospitals	82.56%	98.69%	99.71%	99.86%	100.00%	100.00%	100.00%
Intercity Bus Terminals	44.26%	85.51%	94.52%	99.01%	99.70%	99.97%	100.00%
Railroad Junctions	72.79%	95.79%	99.03%	99.94%	99.99%	100.00%	100.00%
State Police Posts	96.04%	99.73%	99.98%	100.00%	100.00%	100.00%	100.00%
Port	34.50%	59.96%	78.64%	87.81%	94.86%	99.40%	100.00%
Intermodal Freight Facilities	21.26%	38.89%	46.39%	52.23%	57.92%	63.30%	100.00%
Roadside Parks	51.47%	97.85%	99.91%	100.00%	100.00%	100.00%	100.00%
State Parks	32.82%	90.46%	99.61%	99.98%	100.00%	100.00%	100.00%

	2005 Employment						
	15	*30*	*45*	*60*	*75*	*90*	*90+*
Air Carriers	30.12%	71.09%	89.12%	96.22%	98.94%	99.86%	100.00%
Amtrak	64.39%	80.32%	86.67%	89.34%	90.93%	91.63%	100.00%
Business Centers	91.33%	98.20%	99.21%	99.60%	99.96%	99.99%	100.00%
Bus Stations	76.51%	94.53%	98.62%	99.66%	99.94%	100.00%	100.00%
Carpool Parking Lots	78.68%	98.51%	99.65%	99.94%	99.99%	100.00%	100.00%
Colleges and Universities	78.07%	93.03%	97.08%	98.73%	99.70%	99.92%	100.00%
Hospitals	90.27%	99.22%	99.78%	99.86%	100.00%	100.00%	100.00%
Intercity Bus Terminals	53.11%	88.91%	95.56%	99.26%	99.81%	99.99%	100.00%
Railroad Junctions	79.92%	97.11%	99.50%	99.96%	99.99%	100.00%	100.00%
State Police Posts	98.19%	99.85%	99.99%	100.00%	100.00%	100.00%	100.00%
Port	31.86%	60.08%	80.32%	88.49%	94.51%	99.47%	100.00%
Intermodal Freight Facilities	20.13%	40.58%	47.04%	52.55%	57.14%	62.74%	100.00%
Roadside Parks	57.82%	98.71%	99.98%	100.00%	100.00%	100.00%	100.00%
State Parks	36.79%	92.56%	99.80%	99.99%	100.00%	100.00%	100.00%

Table 24: Distance (miles) from Facilities by 2005 Population, Households, and Employment

	2005 Population					
	10	20	30	40	50	50+
Air Carriers	21.77%	53.72%	74.93%	85.72%	92.54%	100.00%
Amtrak	41.46%	68.67%	78.08%	83.75%	86.70%	100.00%
Business Centers	81.32%	95.73%	98.44%	99.14%	99.51%	100.00%
Bus Stations	57.72%	87.02%	95.95%	98.64%	99.46%	100.00%
Carpool Parking Lots	61.73%	95.03%	98.82%	99.68%	99.89%	100.00%
Colleges and Universities	62.87%	85.24%	94.38%	96.94%	98.59%	100.00%
Hospitals	76.03%	96.82%	99.40%	99.79%	99.86%	100.00%
Intercity Bus Terminals	36.72%	76.51%	88.70%	94.44%	98.05%	100.00%
Railroad Junctions	63.03%	92.43%	97.29%	99.12%	99.84%	100.00%
State Police Posts	93.70%	99.42%	99.94%	99.98%	99.99%	100.00%
Port	30.06%	50.40%	65.50%	77.88%	86.02%	100.00%
Intermodal Freight Facilities	17.98%	32.09%	40.43%	44.84%	48.26%	100.00%
Roadside Parks	35.94%	81.09%	99.50%	99.95%	100.00%	100.00%
State Parks	18.08%	54.36%	90.21%	98.54%	99.89%	100.00%

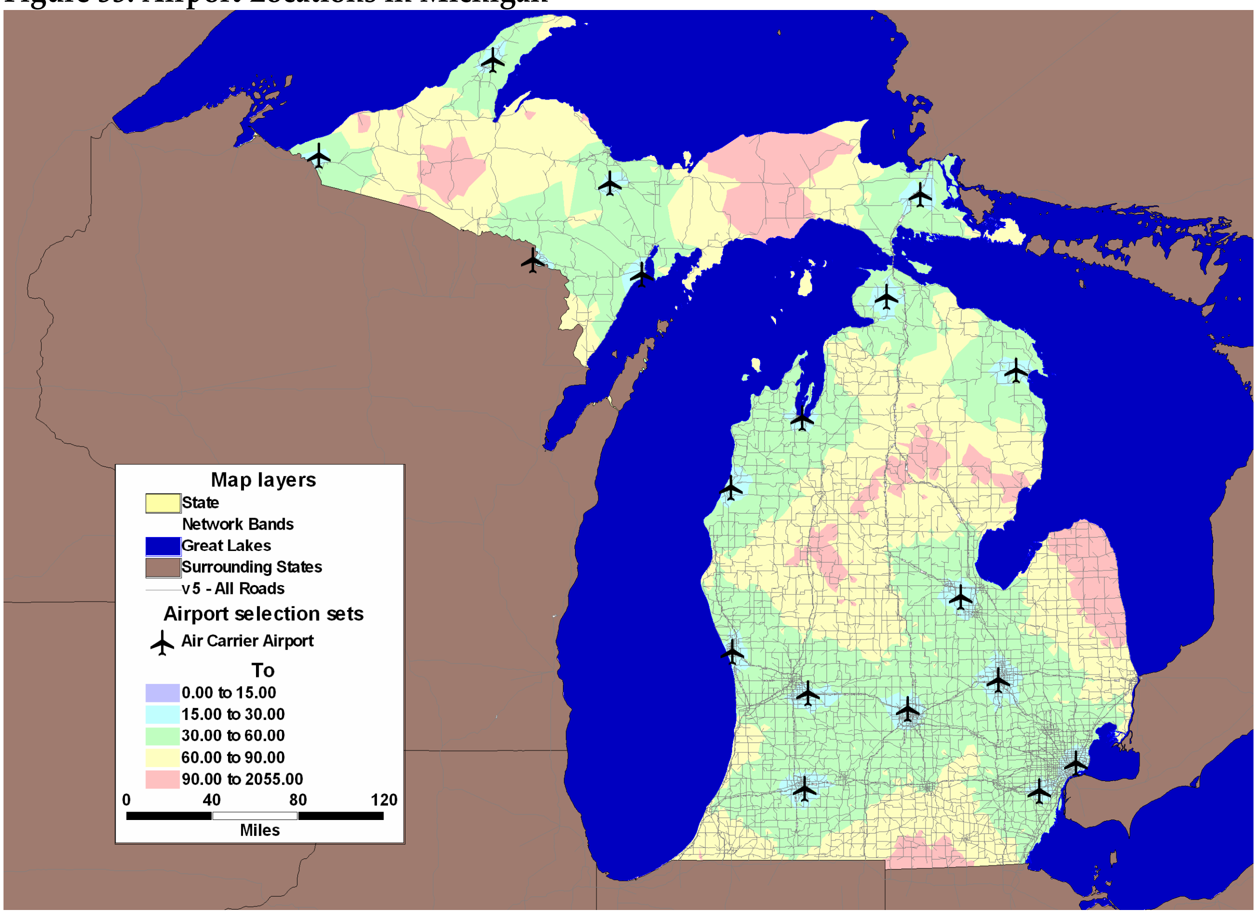
	2005 Households					
	10	20	30	40	50	50+
Air Carriers	22.58%	55.26%	75.80%	86.06%	92.60%	100.00%
Amtrak	42.34%	69.58%	78.51%	83.91%	86.74%	100.00%
Business Centers	82.07%	95.66%	98.37%	99.10%	99.49%	100.00%
Bus Stations	58.89%	87.65%	96.12%	98.67%	99.45%	100.00%
Carpool Parking Lots	61.26%	94.96%	98.77%	99.66%	99.89%	100.00%
Colleges and Universities	64.37%	85.74%	94.36%	96.88%	98.52%	100.00%
Hospitals	77.26%	96.85%	99.38%	99.77%	99.84%	100.00%
Intercity Bus Terminals	36.99%	77.35%	89.20%	94.61%	98.05%	100.00%
Railroad Junctions	63.81%	92.56%	97.22%	99.07%	99.83%	100.00%
State Police Posts	93.93%	99.42%	99.94%	99.98%	99.99%	100.00%
Port	30.88%	51.67%	66.50%	78.61%	86.45%	100.00%
Intermodal Freight Facilities	19.01%	33.89%	42.18%	46.44%	49.67%	100.00%
Roadside Parks	35.94%	80.62%	99.50%	99.95%	100.00%	100.00%
State Parks	17.91%	54.51%	90.46%	98.63%	99.88%	100.00%

	2005 Employment					
	10	20	30	40	50	50+
Air Carriers	25.30%	57.71%	79.91%	88.64%	94.15%	100.00%
Amtrak	49.39%	73.79%	80.32%	85.32%	87.76%	100.00%
Business Centers	89.76%	97.06%	98.74%	99.29%	99.56%	100.00%
Bus Stations	67.91%	90.87%	96.79%	98.74%	99.41%	100.00%
Carpool Parking Lots	64.93%	96.11%	99.10%	99.74%	99.93%	100.00%
Colleges and Universities	73.41%	89.21%	95.44%	97.02%	98.64%	100.00%
Hospitals	86.39%	98.27%	99.57%	99.81%	99.85%	100.00%
Intercity Bus Terminals	45.96%	82.03%	91.47%	95.61%	98.34%	100.00%
Railroad Junctions	70.62%	94.68%	97.88%	99.50%	99.89%	100.00%
State Police Posts	96.93%	99.66%	99.96%	99.99%	100.00%	100.00%
Port	29.06%	50.40%	67.47%	80.35%	87.33%	100.00%
Intermodal Freight Facilities	17.18%	35.42%	42.68%	46.90%	49.58%	100.00%
Roadside Parks	41.93%	80.79%	99.77%	99.98%	100.00%	100.00%
State Parks	20.07%	57.09%	92.56%	98.85%	99.95%	100.00%

4.2.2 Airports with Commercial Service

Figure 33 illustrates the location of airports with commercial service within Michigan. For 2005, it was found that 27 percent of the population, 27 percent of the households, and 30 percent of the employment of Michigan were within 15 minutes of an airport; 95 percent or more of the population, households, and employment were within one hour of an airport. Less than 0.5 percent of the population, households, or employment were more than 90 minutes from an airport with commercial service. The current roadway network provides good accessibility and connectivity to the airports with commercial service.

Figure 33: Airport Locations in Michigan

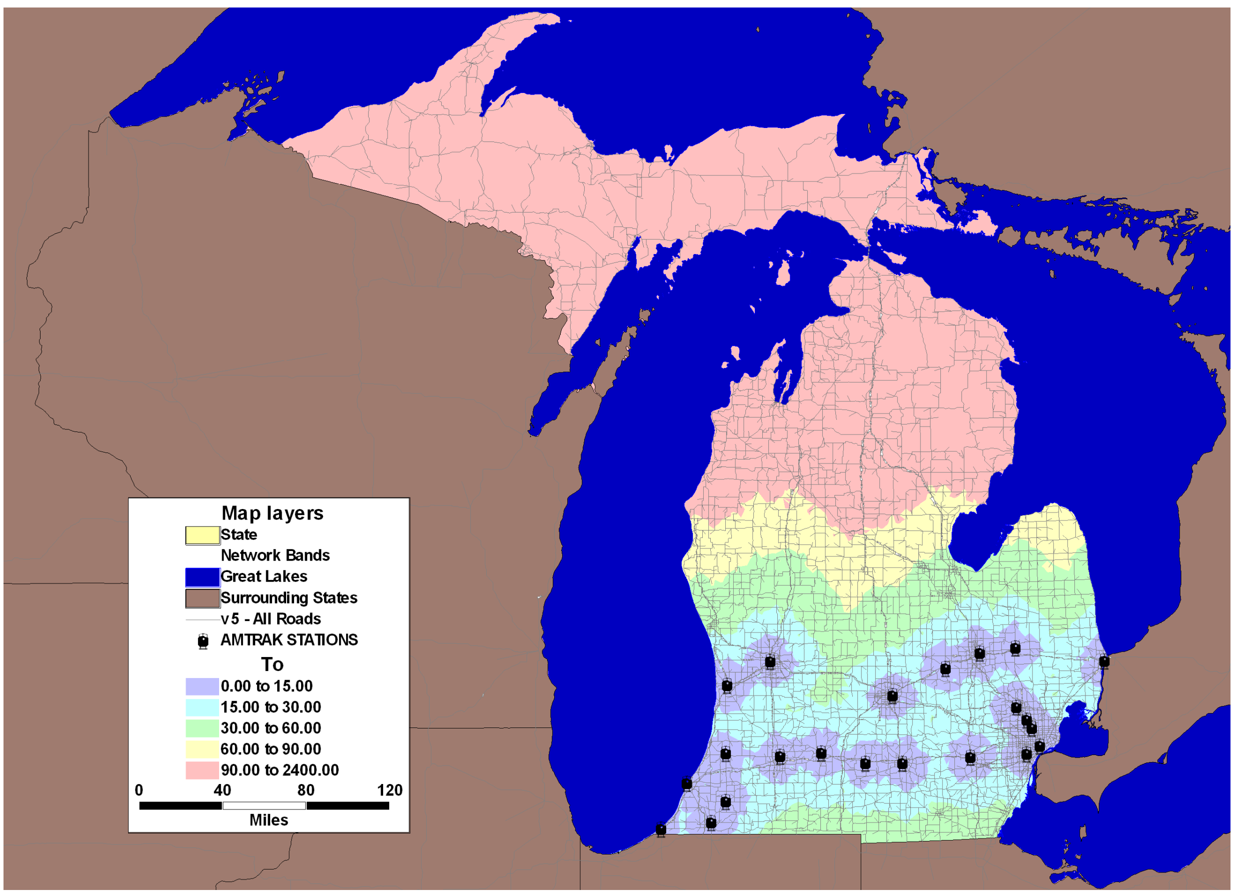


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.3 AMTRAK Stations

Figure 34 shows AMTRAK station locations. For 2005, it was found that 58 percent of the population, 59 percent of the households, and 64 percent of the employment of Michigan were within 15 minutes of an AMTRAK Station; 88 percent of the population, households, and employment were within one hour of an AMTRAK Station. Conversely, 9 percent of population, households, and employment were more than 90 minutes from an AMTRAK Station. **Figure 34** illustrates that northern Michigan has poor accessibility to AMTRAK stations but most of the state's population, households, and employment have good access to these facilities.

Figure 34: AMTRAK Station Locations

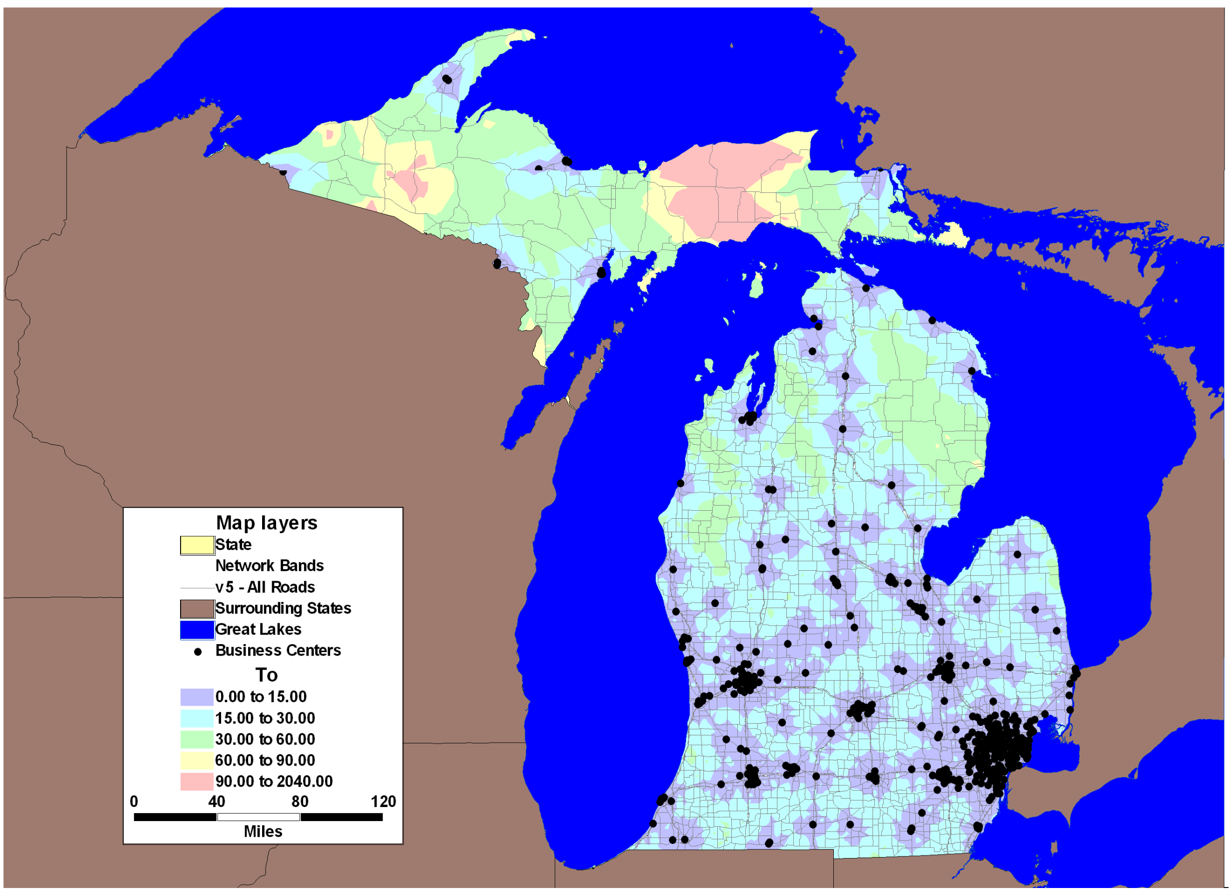


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.4 Business Centers

Figure 35 illustrates business center locations within Michigan. For 2005 it was found that 84 percent of the population, 85 percent of the households, and 91 percent of the employment in Michigan were within 15 minutes of a Business Center; 99 percent of the population, households, and employment were within one hour of a Business Center, and less then 0.1 percent of population, households, and employment were more than 90 minutes from a business center. The current roadway network provides good connectivity and access to these employment centers.

Figure 35: Business Center Locations

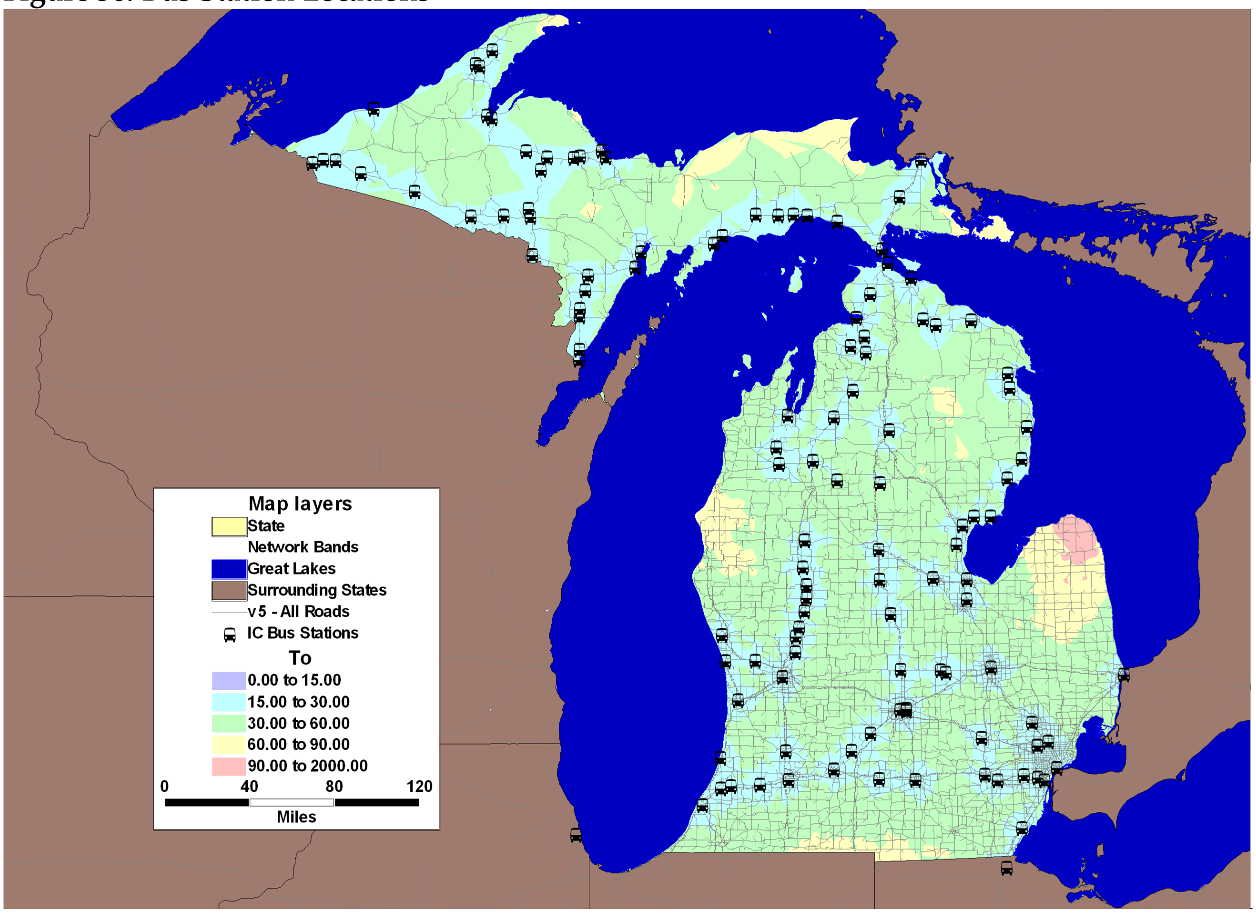


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.5 Bus Stations

Figure 36 shows bus station locations. For 2005, it was found that 67 percent of the population, 68 percent of the households, and 77 percent of the employment in Michigan were within 15 minutes of a bus station; 99 percent of the population, households, and employment were within one hour of a bus station. Less than 0.1 percent of population, households, and employment were more than 90 minutes from a bus station. The current roadway network provides good connectivity and access to bus stations.

Figure 36: Bus Station Locations

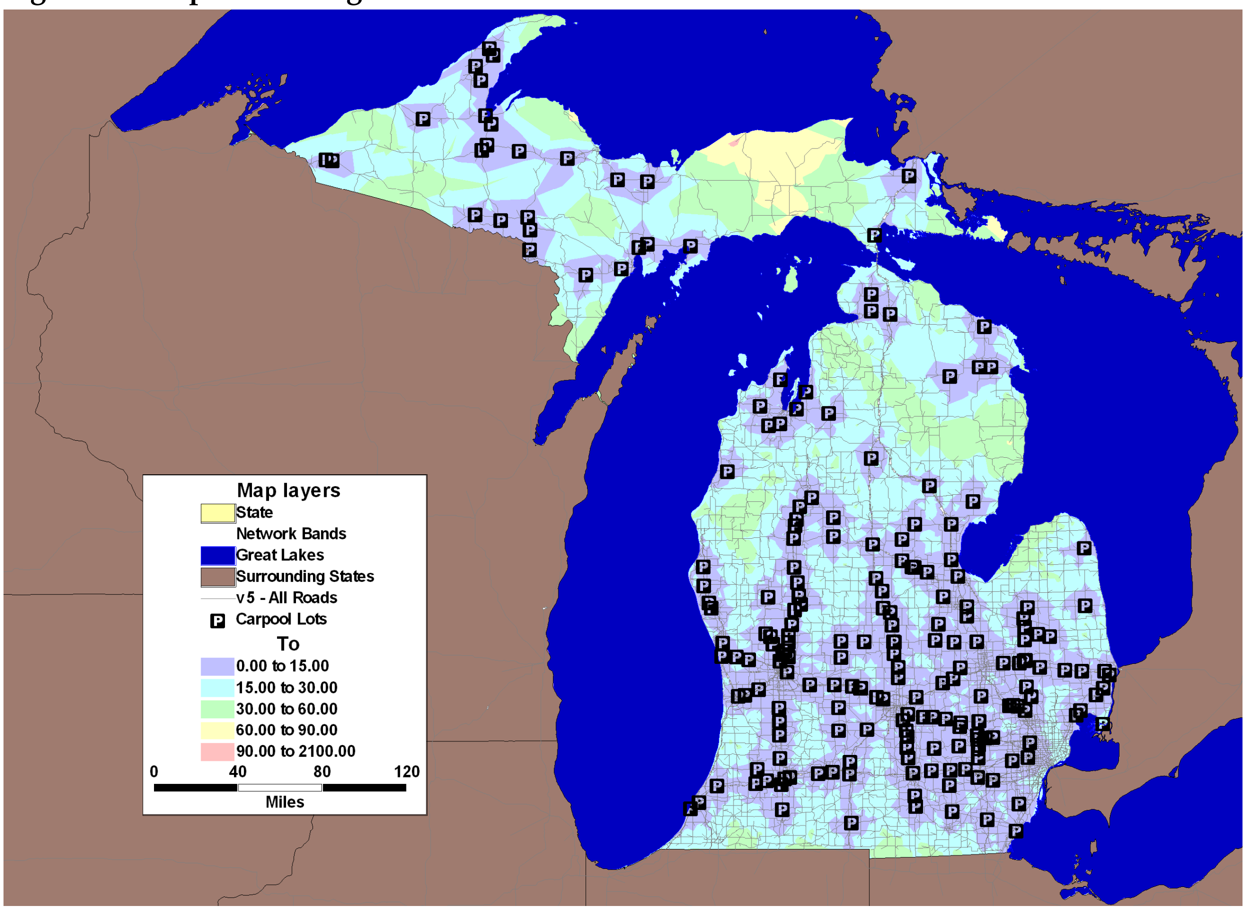


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.6 Carpool Parking Lots

Figure 37 illustrates carpool parking lots locations within Michigan. For 2005, it was found that 75 percent of the population, 75 percent of the households, and 79 percent of the employment in Michigan were within 15 minutes of a CPL; 99 percent of the population, households, and employment were within 45 minutes of a CPL. No population, households, or employment were more than 90 minutes from a CPL. The current roadway network provides good connectivity and access to carpool parking lots.

Figure 37: Carpool Parking Lot Locations

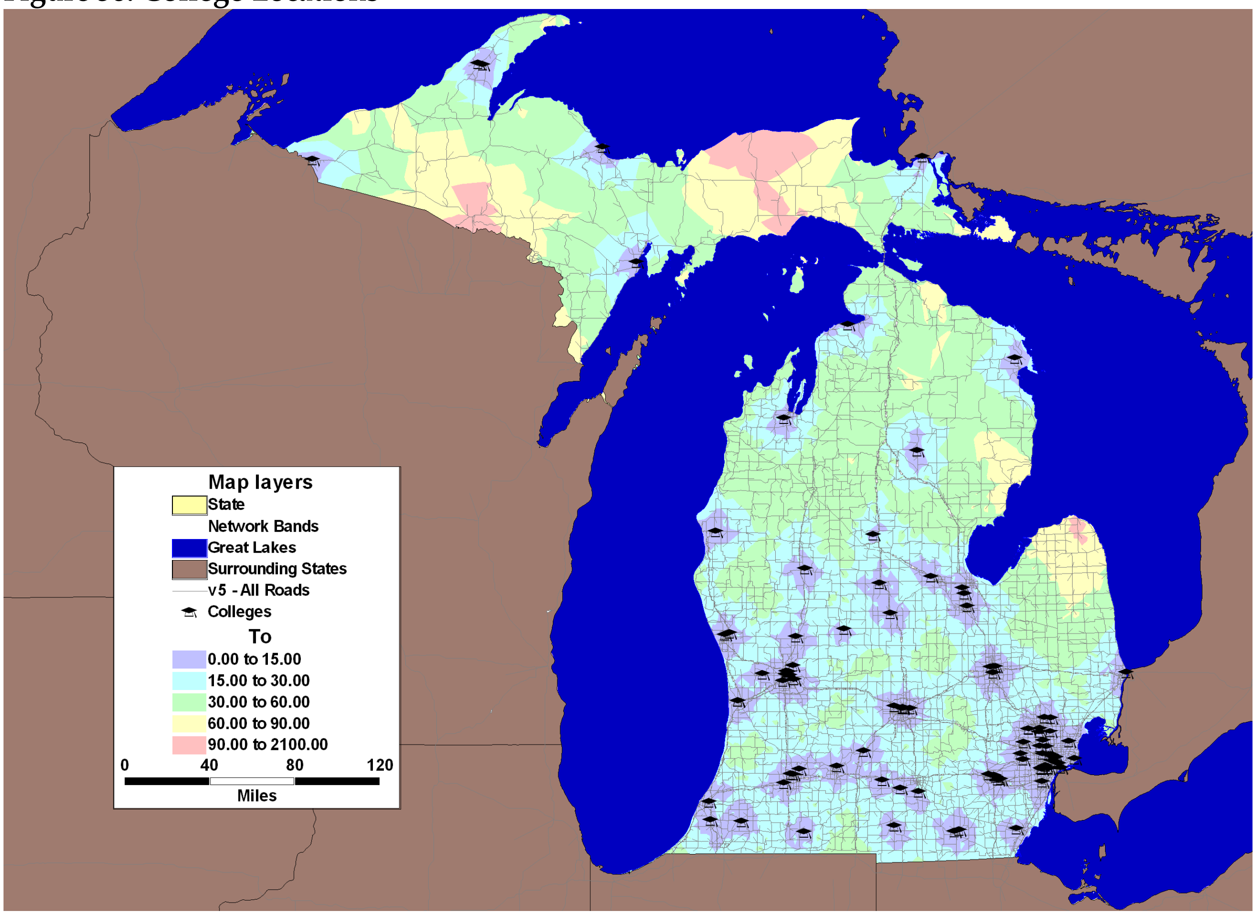


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.7 Colleges

Figure 38 shows the locations of colleges in Michigan. For 2005, it was found that 68 percent of the population, 70 percent of the households, and 78 percent of the employment in Michigan were within 15 minutes of a college; 99 percent of the population, households, and employment were within 60 minutes of a college. Less than 0.2 percent of the population, households, and employment were more than 90 minutes from a college. The current roadway network provides good connectivity and access to these colleges and universities.

Figure 38: College Locations

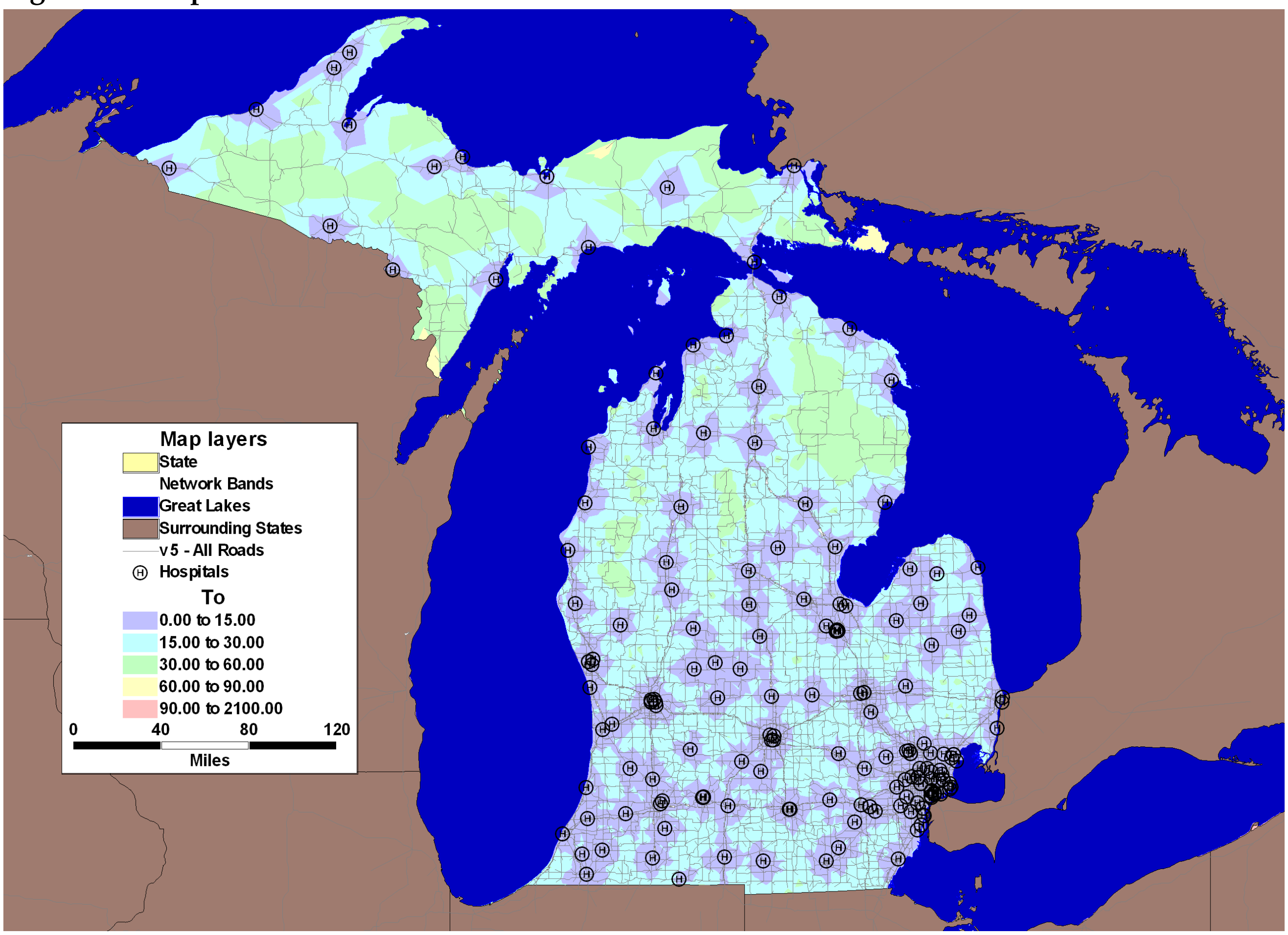


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.8 Hospitals

Figure 39 illustrates hospital locations. For 2005, it was found that 82 percent of the population, 83 percent of the households, and 90 percent of the employment in Michigan were within 15 minutes of a hospital; 99 percent of the population, households, and employment were within 45 minutes of a hospital. No population, household, or employment was more than 75 minutes from a hospital. The current roadway network provides good connectivity and access to hospitals.

Figure 39: Hospital Location

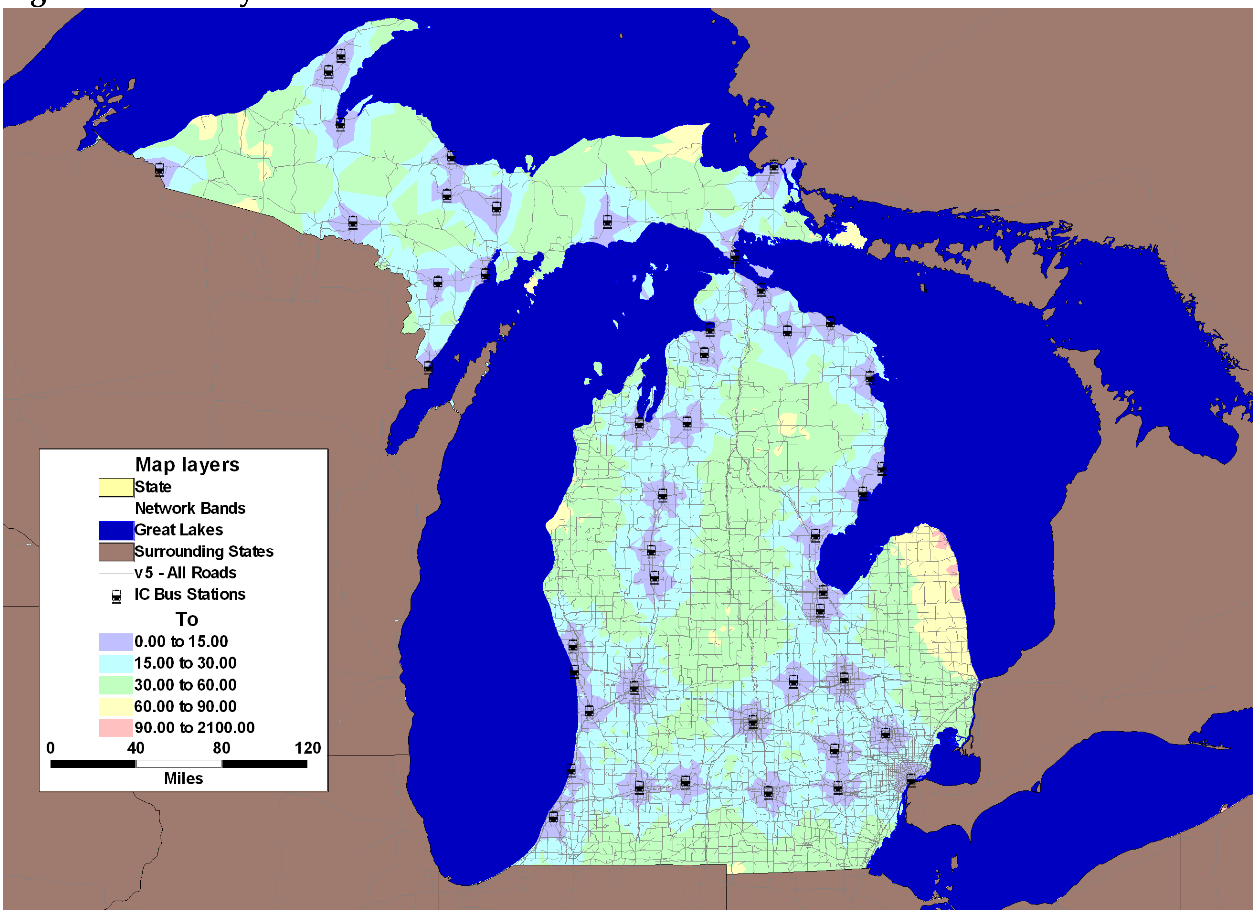


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.9 Intercity Bus

Figure 40 shows the locations of intercity bus stations. For 2005, it was found that 44 percent of the population, 44 percent of the households, and 53 percent of the employment of Michigan were within 15 minutes of an intercity bus station; 99 percent of the population, households, and employment were within 60 minutes of an intercity bus station. Less than 0.1 percent of the population, households, and employment were more than 90 minutes from an intercity bus station. The current roadway network provides good connectivity and access to these intercity bus stations.

Figure 40: Intercity Bus Station Locations

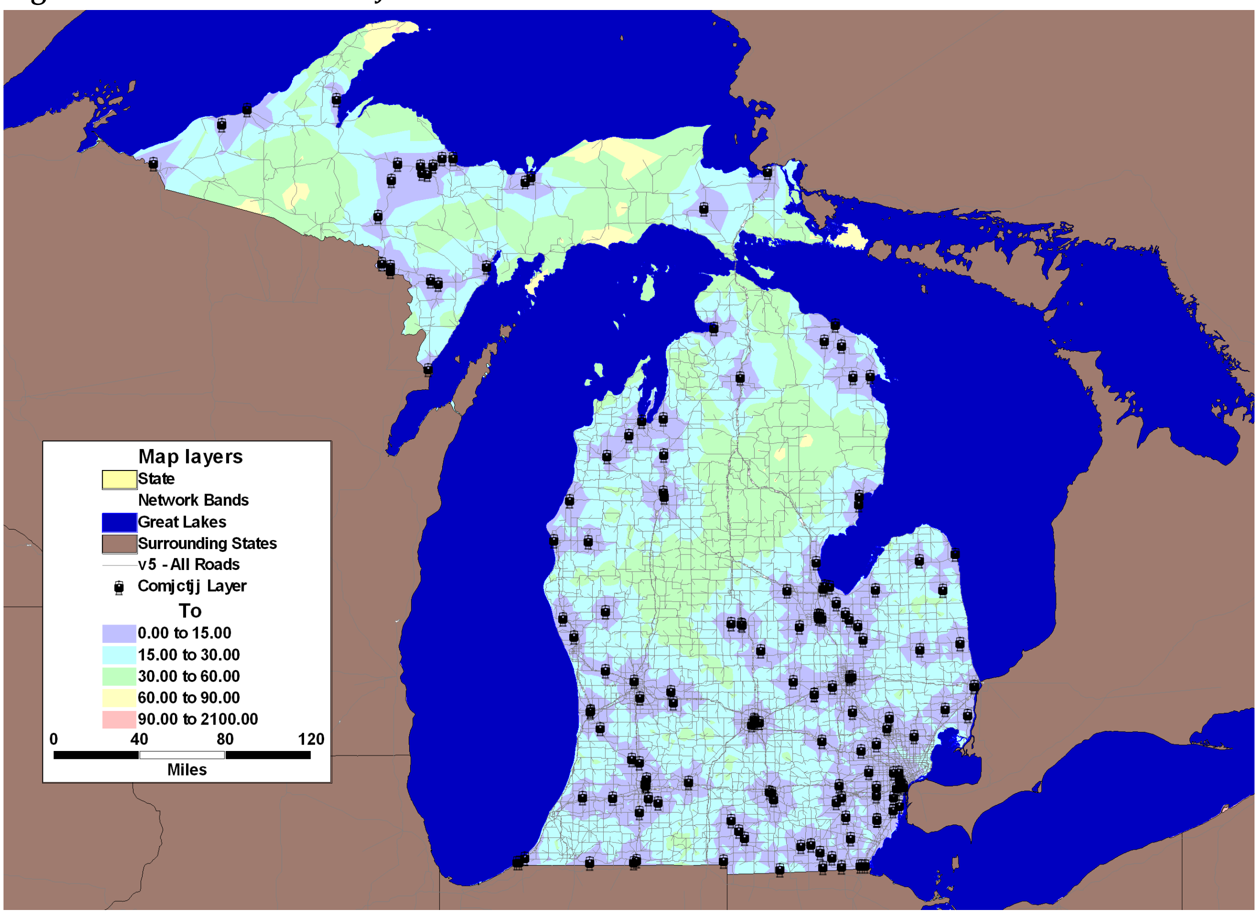


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.10 Commercial Rail Junctions

Figure 41 shows commercial rail junction locations in Michigan. For 2005, it was found that 72 percent of the population, 73 percent of the households, and 80 percent of the employment in Michigan were within 15 minutes of a commercial rail junction; 99 percent of the population, households, and employment were within 45 minutes of a commercial rail junction. No population, households, or employment was more than 90 minutes from a commercial rail junction. The current roadway network provides good connectivity and access to the commercial rail junctions.

Figure 41: Commercial Rail Junction Locations

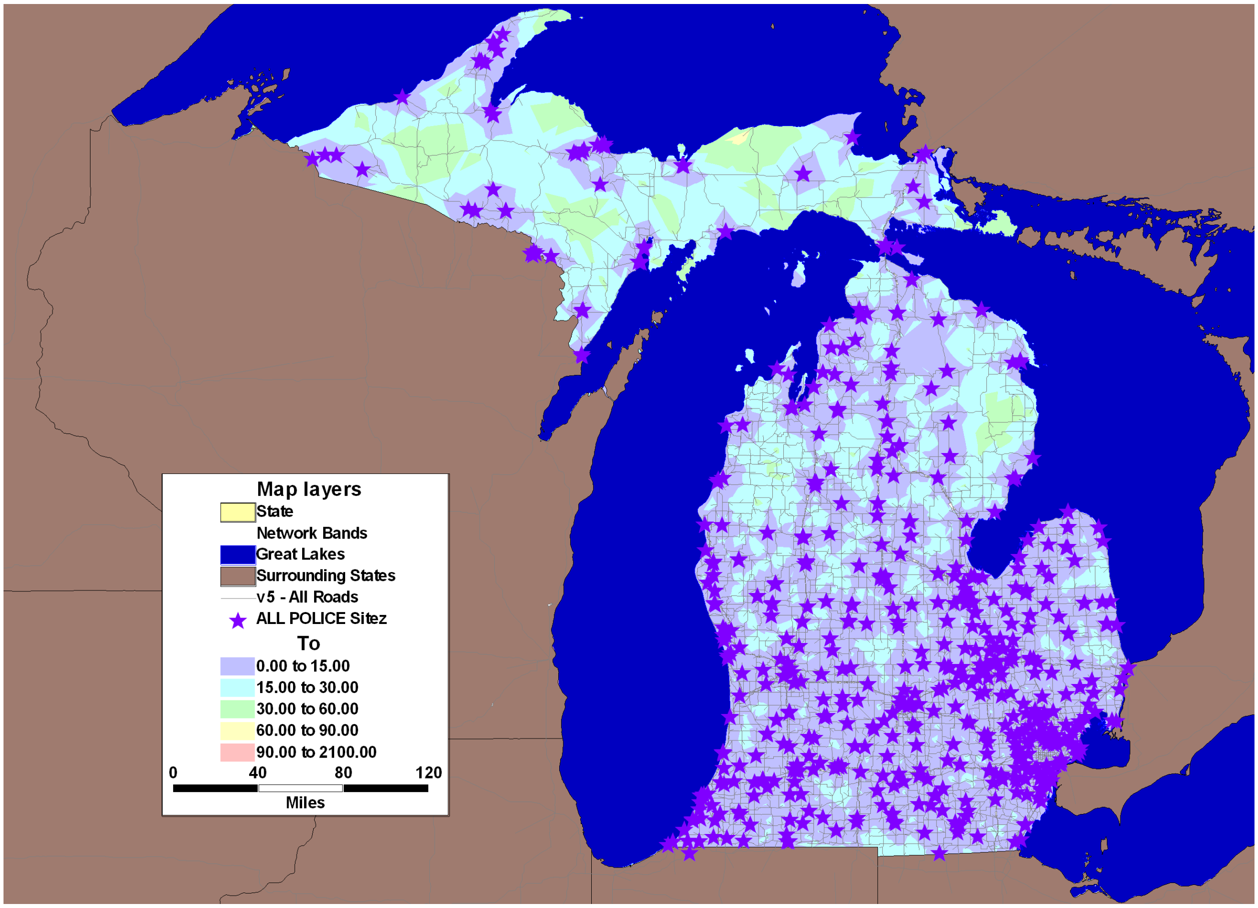


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.11 State Police Posts

Figure 42 shows state police post locations within Michigan. For 2005, it was found that 96 percent of the population, 96 percent of the households, and 98 percent of the employment in Michigan were within 15 minutes of a state police post; 99 percent of the population, households, and employment were within 30 minutes of a state police post. No population, households, or employment was more than 60 minutes from a state police post. The current roadway network provides good connectivity and access to these police posts.

Figure 42: State Police Post Locations

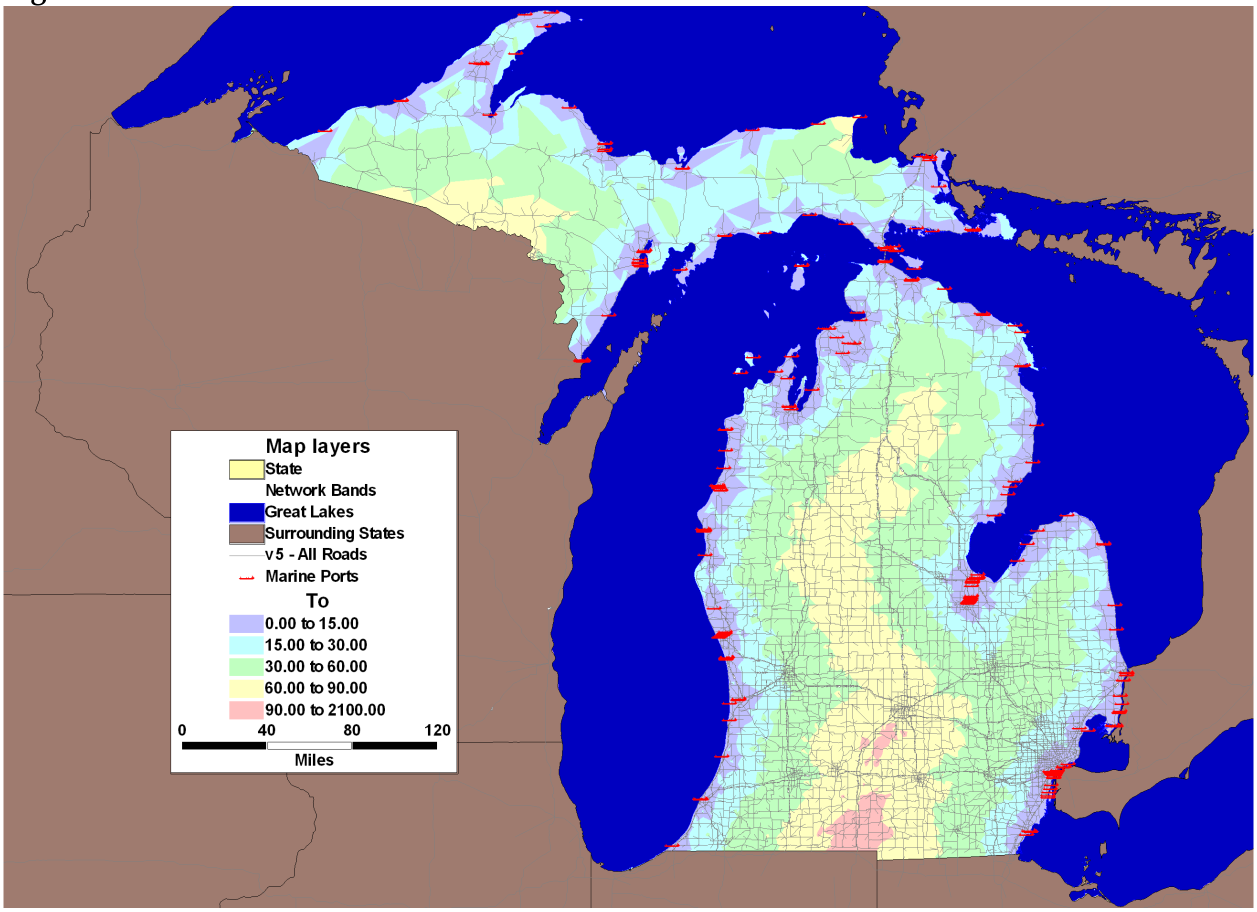


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.12 Commercial Marine Ports

Figure 43 shows the locations of Michigan's commercial marine ports. For 2005, it was found that 34 percent of the population, 35 percent of the households, and 32 percent of the employment in Michigan were within 15 minutes of a commercial marine port; 87 percent of the population, households, and employment were within one hour of a commercial marine port. Less than one percent of population, households, and employment was more than 90 minutes from a commercial marine port. The current roadway network provides good connectivity and access to the commercial marine ports.

Figure 43: Commercial Marine Port Locations

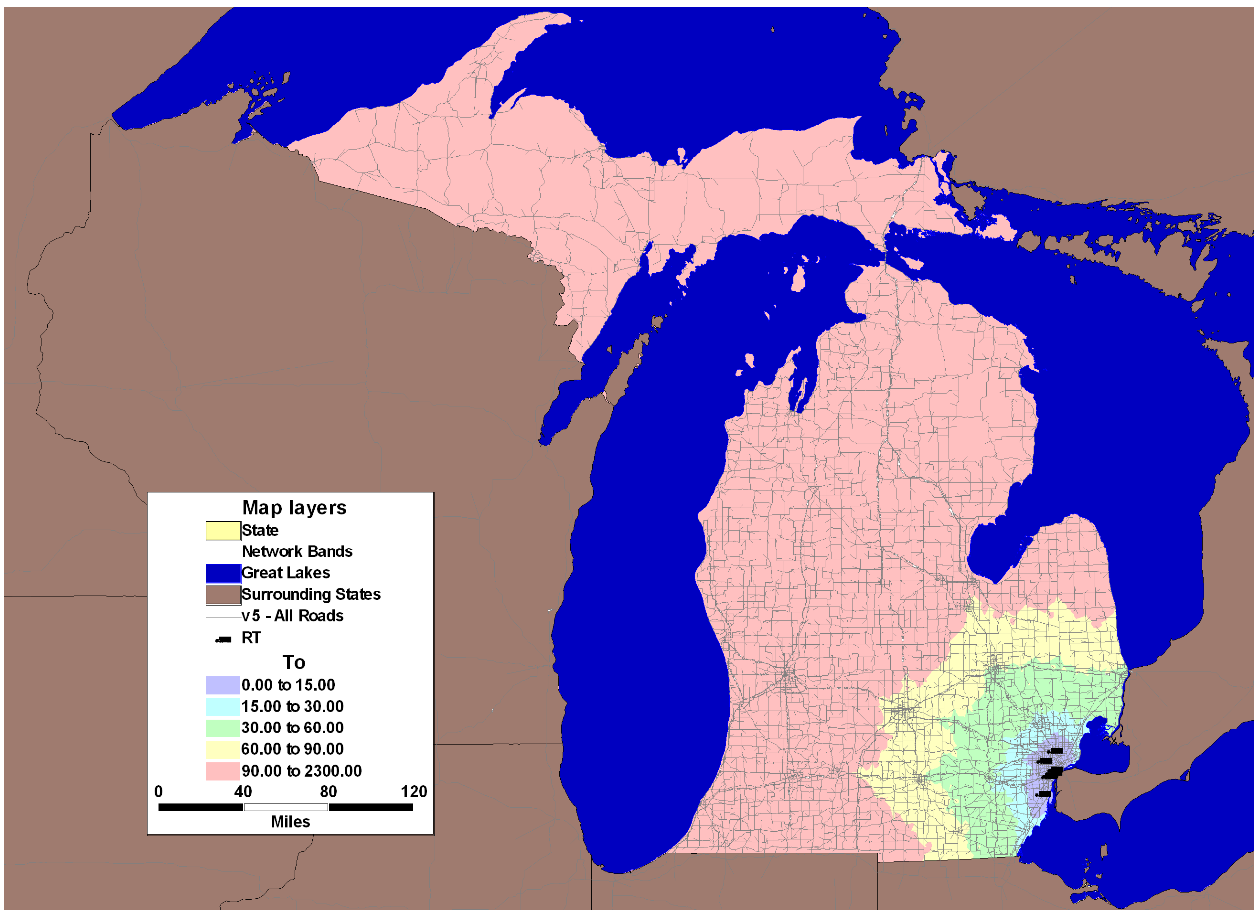


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.13 Intermodal Freight Terminals

Figure 44 illustrates the locations of intermodal freight terminals. For 2005, it was found that 20 percent of the population, 21 percent of the households, and 20 percent of the employment in Michigan were within 15 minutes of an intermodal freight terminal and that 63 percent of the population, households, and employment were within 90 minutes of an intermodal freight terminal. More than 37 percent of population, households, and employment were more than 90 minutes from an intermodal freight terminal. **Figure 44** also illustrates that outside of Metro Detroit there is poor accessibility to intermodal freight terminals and just over 50 percent of the state's population, households, and employment have access within one hour of these facilities.

Figure 44: Intermodal Freight Terminal Locations

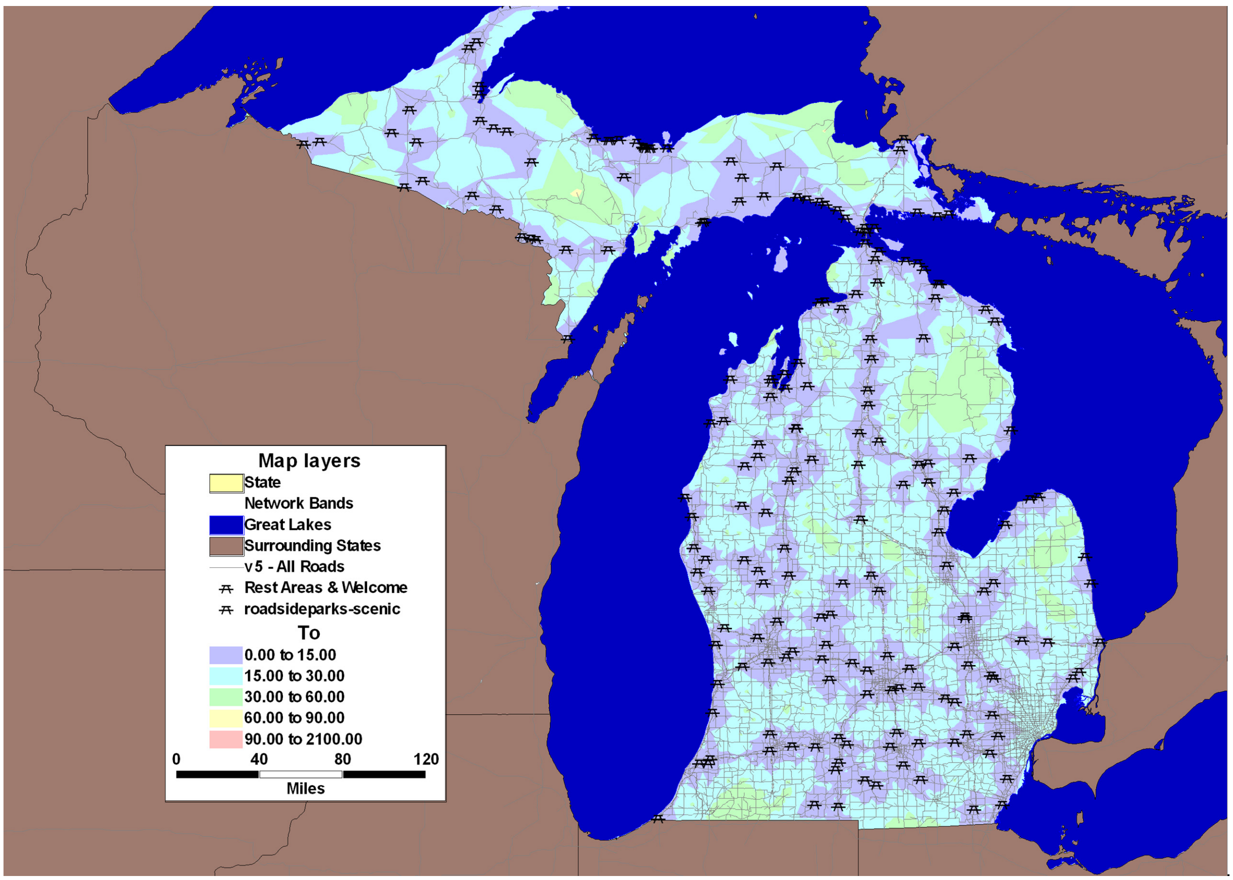


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.14 Roadside Parks and Rest Areas

Figure 45 shows the locations of roadside parks and rest areas in Michigan. For 2005, it was found that 52 percent of the population, 52 percent of the households, and 58 percent of the employment of Michigan were within 15 minutes of a roadside park or rest area; 99 percent of the population, households, and employment were within 45 minutes of a roadside park or rest area. Less than 0.1 percent of population, households, and employment were more than 60 minutes from a roadside park or rest area. The current roadway network is supported by the good connectivity and access to these roadside parks and rest areas.

Figure 45: Roadside Park and Rest Area Locations

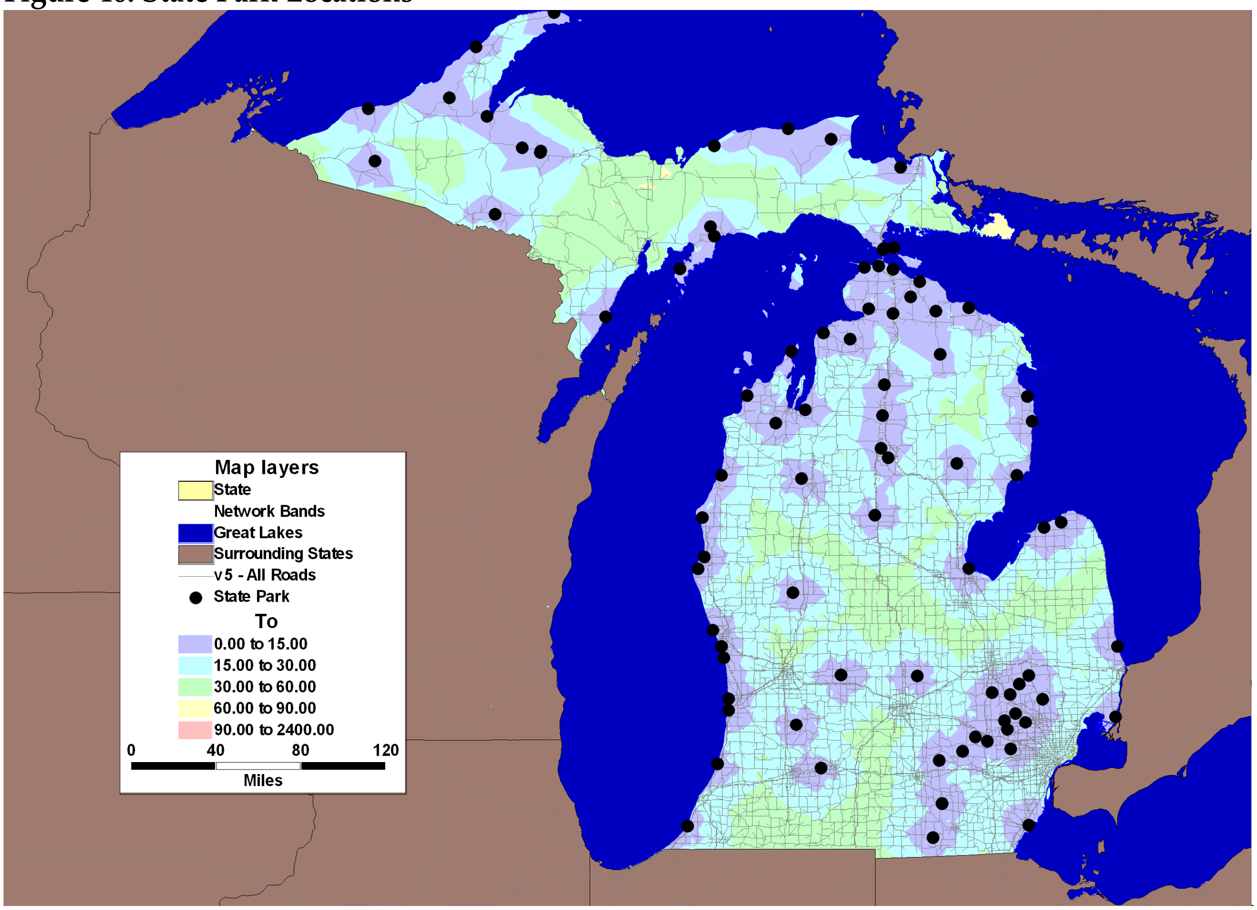


Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.2.15 State Parks

Figure 46 shows state park locations within Michigan. For 2005, it was found that 33 percent of the population, 33 percent of the households, and 37 percent of the employment of Michigan were within 15 minutes of a state park; 99 percent of the population, households, and employment were within 45 minutes of a state park. Less than 0.1 percent of population, households, and employment were more than 75 minutes from a state park. The current roadway network provides good connectivity and access to the state park system.

Figure 46: State Park Locations



Source: Michigan Department of Transportation, Statewide Travel Demand Model

4.3 Non-Pavement Infrastructure

This section will briefly discuss other non-pavement infrastructure capital needs. These needs will only be mentioned in the context that they are an integral part of Michigan's trunkline highway and bridge system. The detail for many of the areas mentioned can be obtained by referencing the pertinent technical reports.

4.3.1 Traffic and Safety Capital Outlay Program

The Traffic and Safety Capital Outlay Program is an important and, in some ways, unique aspect of highway management. This program includes traffic control devices, guardrail, and safety projects, some of which cannot be identified more than a few years in advance. The goal of the program is:

> *To serve the public's transportation needs through application of comprehensive highway traffic engineering technology; participating in all phases of the department's effort to reduce traffic crashes and injuries, vehicle delay, fuel consumption, pollution, and operating costs by increasing the safety, efficiency, and capacity of the state highway trunkline system.*

The program purpose and project selection process is described below for the following categories:

- Signing;
- Pavement marking;
- Guardrail replacement;
- Traffic signals; and
- Safety programs.

4.3.1.1 Signing

The purpose of this program is to upgrade MDOT signs with long-life sheeting. The projects in this category are developed based on age and condition of signs in place along various freeway and non-freeway corridors. MDOT uses reflective sheeting backgrounds and legends on all new regulatory, warning, and guide signs. Effectiveness of the reflective sheeting on these signs eventually diminishes over time; therefore, periodic sign replacement is necessary. MDOT has developed a statewide program of periodically replacing signs on the trunkline system. This program permits the department to maintain safe and effective signing on all roadways. The average roadway should undergo a complete sign update approximately every 15 years. This program's goal is to address roadway segments having overall sign life, replacing all signs in a corridor meeting the following criteria:

1. Change and update sign legends to meet the needs of changing and growing traffic patterns throughout the state of Michigan.
2. Replace regulatory, warning, and guide signs along the trunkline mainline and on ramps and crossroads within project limits.

3. Replace or improve sign installations that do not meet current standards for height, lateral offset, and location.
4. Replace signposts and foundations that do not meet current structural standards for crash worthiness.
5. Replace SD overhead sign structures and their foundations.
6. Replace signs not conforming to the *Michigan Manual of Uniform Traffic Control Devices* or to MDOT's *Standard Highway Signs Book*.
7. Replace signs not conforming to MDOT's *Guidelines for Signing on State Trunkline Highways*.

In addition, large overhead sign support structures such as trusses, cantilevers, and bridge-mounted sign structures are part of the signing program as stand-alone projects. The department evaluates these structures and makes a determination of replacement or retention, per MDOT's sign support typical plans. All sign upgrading projects are coordinated with the department's five-year road preservation program, if possible, or let as separate projects. The signing program operates on a five-year project selection process.

4.3.1.2 Pavement Marking

The Traffic and Safety Support Area's core strategy for a five-year program in pavement marking is a continuation of the department's current practice: conduct annual re-striping of the trunkline system. We continue to work with suppliers, distributors, contractors, and researchers in an effort to find a cost-effective pavement marking which provides year-round, all-weather retro-reflectivity. Material type selection is done in accordance with approved department pavement marking materials usage guidelines.

4.3.1.3 Guardrail Replacement

This category was initiated to replace the A-588 weathering steel, "rusty rail" on freeways. Due to the system's aging and continuous efforts to improve roadside safety, this program was expanded to include other deficient roadside barriers on all state trunklines. It also addresses safety needs based on "high-crash" locations. Several projects installing median barriers on I-75, I-94, and US-23 to eliminate cross median crashes have been constructed. The projects are selected based on type of system, average daily traffic, crash experience, and general condition of the guardrail. This program is coordinated with the road preservation program, as well as the CPM program. Due to the need to coordinate with other programs and address safety issues in a timely fashion, this program is planned on a two-year cycle.

4.3.1.4 Traffic Signals

Traffic control signal projects and other safety improvements are not generated in a long-term project list format. Traffic control signal needs, such as new or revised signal phasing and new installations, are defined through a continuing operational and crash analysis program. Uniform federal and state guidelines are followed to define new installation locations and operational improvements to meet the motoring public's needs. Current year program funding is provided to meet all operational and safety needs identified on a priority basis.

Traffic control signal infrastructure maintenance upgrades are identified on a continuing basis from recommendations made by the regional maintenance electricians. These recommendations are used during development of the five-year modernization (maintenance upgrade) program. All modernization projects are coordinated on a corridor improvement basis with the roadway construction improvement program.

4.3.1.5 Safety Programs (Road Construction Improvements)

The projects in this category are developed in response to analyses of traffic crashes and crash patterns. The majority of sites requiring crash analyses are identified through one of the following:

1. A regularly scheduled review of computer-generated locations statewide, which exhibit higher than typical crash records.
2. Intersections requiring improvements to accommodate traffic with new stop-and-go signals/revised phasing.
3. Safety analysis required in early scoping of all MDOT proposed reconstruct and improve/expand projects.
4. Pavement Management System pavement friction testing program.
5. Public requests/concerns regarding traffic crashes.

Upon completion of the crash analysis a cost/benefit analysis (time-of-return) is conducted for the proposed improvement. Benefits for the proposed improvement are derived from the anticipated reduction of fatalities/severe injuries and minor/property damage only crashes at the concerned location. Proposed improvements having a time-of-return at or below a predetermined level are eligible for safety funding. In the FY 2011 Call for Project process, the maximum time-of-return is 10 years.

4.3.2 Drainage

MDOT is experiencing an increase in drainage structure failure, particularly in regard to aging culverts. There is a need to inventory and identify culverts and other significant drainage structures, identify those in need of repair or replacement, and advance those projects. Without a complete inventory, it is not possible to quantify the scope of this need at this time. There is a prioritized effort underway to inventory and evaluate important components in the storm water management system that should develop an inventory of key outfalls and structures and prioritize maintenance needs within the next five years. Completion of this effort will enable MDOT to determine how effective these aspects of its overall storm water system are and what improvements are needed.

4.3.3 Weigh Stations

Until strategies for weight enforcement are agreed to, and infrastructure support (if any) are agreed to, there are no "needs."

4.3.4 Non-Motorized Facilities

A non-motorized network that is comprehensive and integrated into the trunkline highway and bridge program requires education, planning, and coordination. This can be achieved by routinely considering non-motorized facilities in the scoping and design process of all major road construction or reconstruction projects. The development of non-motorized Regional Investment Plans will help MDOT staff understand the non-motorized needs of the community and identify the highest priority locations. By regularly referencing these plans, it is possible to consider the provision of non-motorized facilities early on and demonstrate a proactive approach to community concerns.

4.3.5 Type II Noise Abatement Commission Policy

The Michigan STC approved a Type II Noise Abatement Policy on July 31, 2003. It is a voluntary program designed to address traffic noise along existing state highways that may negatively impact residential neighborhoods. Detailed information and guidelines from the STC approved policy is provided below.

The policy addresses Type II noise abatement to limit the intrusion of highway noise into adjacent residential areas to reasonably achievable levels consistent with the US Department of Transportation's (USDOT) Code of Federal Regulations (CFR). It takes into consideration MDOT's life cycle cost analysis and safety requirements, as well as other technical and financial implications. To achieve this objective the STC supports the following four approaches to alleviate traffic noise impacts:

1. **Reduction of Noise at the Source.** Reduction of traffic noise by design or treatment of the road surface is the most cost-effective noise control available to MDOT. Within the group of noise abatements that are reasonable and feasible under 23 CFR 772, and after MDOT's life-cycle cost analysis has selected a pavement type and other technical and financial constraints, MDOT will use the quietest surface texture available when repaving/reconstructing a freeway in residential areas.

2. **Noise Abatement.** MDOT will attempt to locate, design, construct, and operate state highways to minimize the intrusion of traffic noise into adjacent areas. When noise impacts occur, they may be attenuated by the most reasonable and prudent means.

   MDOT will construct Type II sound walls only in years when MDOT's Road and Bridge Program, excluding maintenance, exceeds $1.0 billion, adjusted to the Consumer Price Index (CPI) using 2002 as the base year. MDOT will not spend more than one-half of one percent of the budget on sound walls. MDOT will give priority to those communities where the freeway was constructed through an existing neighborhood and where 80 percent or more of the existing residential units were there prior to the construction of the freeway. Communities must make application to MDOT and provide a local match of 10 percent of the cost of the sound wall.

3. **Encouraging Compatible Adjacent Land Use.** Cities and counties have the power to control development by adoption of land use plans and zoning, and by subdivision, building, or housing regulations. The commission encourages those who plan and develop land, and local governments controlling development or planning land use near known freeway locations, to exercise their powers and responsibility to minimize the effect of highway vehicle noise through appropriate land use control. Where such land use regulations are not in place, cities, townships, and counties will not be eligible for MDOT noise mitigation assistance.

4. **Noise Abatement by Others.** The Commission encourages developers and local governments to coordinate their efforts to mitigate highway noise. This effort must be done without encroachment of MDOT's property ROW unless it is determined to be necessary, and authority granted to permit others to construct a sound barrier in the state's ROW. The barrier's design must meet MDOT's geometric, structural, safety and maintenance standards. MDOT shall assume no review authority or responsibility of any kind for the structural integrity or the effectiveness of a sound barrier constructed by others.

4.4 Special Technology Deployment

This section will address the deployment of Intelligent Transportation Systems (ITS) and other technology solutions on the Michigan system, the status of programs like the Vehicle Infrastructure Initiative (VII), Permanent Traffic Recorders (PTR), and Weigh-in-Motion (WIM) technologies to improve system performance.

4.4.1 Intelligent Transportation Systems

A safe and efficient multi-modal transportation system is a critical component of Michigan's economy and quality of life. The movement of people and goods across all transportation modes has a direct bearing on employment, shopping, entertainment, industry, and economic development. In the face of growing populations, increasing transportation demand, straining infrastructures, and diverse transportation modes, many people are looking to ITS as the next step in the evolution of the overall transportation system.

ITS is the application of innovative information technologies and advanced electronics to revolutionize the efficiency of all modes of the transportation system. These technologies include the latest in computers, electronics, communications, and safety systems, both in vehicles and in the infrastructure. ITS is not the only solution, but it has already been proven to be a powerful and cost-effective alternative to infrastructure expansion.

MDOT recognized the potential growth of these ITS technologies and formed an ITS steering committee in August 2003, to provide consistent guidance and policies for MDOT's ITS program development. The first charge of MDOT's ITS Steering Committee's was to develop the ITS Strategic Plan for MDOT.[10] The objective of this plan is to provide both high-level visionary guidance, and practical proactive direction for MDOT as it plans, develops, and implements ITS programs and projects. MDOT seeks to identify and deploy appropriate ITS applications and strategies by working collaboratively with key partners. The combined effort will leverage ITS technologies that maximize the safety and efficiency of all modes of the transportation system for the ultimate benefit of all stakeholders.

The plan includes MDOT's ITS Mission, Vision, and Values aligned with the supporting environment of both state and national transportation objectives to contribute to a unified multi-modal statewide ITS program. These broad statements are important for indicating MDOT's ITS direction to stakeholders both inside and outside the department. In addition, specific achievable goals are also provided to begin realizing the improved ITS-enabled transportation system of the future. The goals include, but are not limited to, the establishment of a dedicated ITS Program Office, the mainstreaming of ITS business processes, management, and funding, and the construction of an ITS test bed for the development of VII technologies in cooperation with MDOT's industry partners. Finally, the plan includes a collection of applicable business tools in the form of processes, schedules, and plans. These tools will help the organization manage change and measure progress in the MDOT ITS Strategic Plan over time.

Since the mid-1960s, Michigan has been involved in ITS with the monitoring of traffic and conditions by Closed Circuit Television (CCTV) and sensing devices, combined with motorist advisories via Dynamic Message Signs (DMS) and dedicated radio broadcasts. In Detroit and Grand Rapids, complex telecommunications systems are monitored by traffic management centers operated jointly by MDOT and the state or local law enforcement agencies. The Michigan Intelligent Transportation System Center in Detroit is one of the largest Advanced Traffic Management Systems (ATMS) deployments in the nation and provides real-time traffic information to the public via the Internet.

The Freeway Courtesy Patrol (FCP) was established in 1994 with two drivers along I-75 in Detroit. Over the next 12 years, the FCP was expanded to include 34 vehicles patrolling 12 freeways in Metro Detroit 24 hours a day, 365 days a year. Services provided by the FCP include changing flat tires, providing fuel to vehicles that have run out, assisting emergency responders at accident scenes, removing debris from the roadway, and providing a tow service to stranded motorists (towing within five miles of the point of breakdown is provided at no charge to motorists).

For every minute that an incident (whether it be an accident or vehicle breakdown) occurs on a freeway, there is a potential to impact and slow down traffic for up to six minutes. The FCP was implemented to minimize the impacts of these incidents on normal freeway traffic operation. Based on a detailed analysis performed by the Southeast Michigan Council of Governments (SEMCOG) in 2003, using data supplied by MDOT, the FCP clears an incident from the roadway at an average of 14 minutes. This has equated to an annual estimated 10.3 million hours of delay saved on the Metro Detroit freeway system. A cost-benefit analysis

[10] Source: *MDOT ITS Strategic Plan*, September 3, 2004

performed as part of this same comprehensive analysis shows that $14.40 of savings is realized for every $1 spent on the program.

4.4.2 Vehicle Infrastructure Initiative

Vehicle Infrastructure Integration (VII) is an emerging ITS initiative aimed at creating linkages between intelligent vehicles and infrastructure systems for use in a variety of applications. Whereas traditional ITS technologies rely on infrastructure-based systems to collect and process data, VII systems would enable intelligent vehicles to collect data, communicate data to the infrastructure, and receive communication regarding safety hazards, travel conditions, or other information valuable to users. Today's marketplace is teaming with mature technologies that are technically and economically feasible. One question remains to be answered: are they capable of supporting VII?

4.4.2.1 VII Opportunities

The state of Michigan, as home to the US auto industry, has the unique opportunity to support the development and testing of a range of technologies and products in partnership with automotive manufacturers and suppliers. Supporting this testing will require an investment in the public infrastructure necessary to create functional test beds for use in evaluating the technical feasibility, deployment issues, and various potential use cases of VII.

The concept of VII holds the promise of forever changing the way MDOT and the public sector do business with regard to operations and maintenance. However, much work is required for VII to be implemented in the US. The technical and institutional challenges are extensive and will require time to overcome. Furthermore, VII is not even possible without the ability for vehicles to communicate data with the roadside infrastructure and for backhaul communications to potentially carry this vast amount of data to control centers or other central locations. Once data is communicated to the infrastructure, the data can be shared, fused, packaged, and disseminated from a wide range of providers to a wide range of users.

4.4.2.2 VII Subsystems

The three key subsystems being evaluated as part of this program are:

- On Board Equipment (OBE) – The components installed in vehicles, which may or may not include integration with the various vehicle systems. This equipment includes the wireless communications in the vehicle, including the components necessary for vehicle-to-vehicle (V2V) communications.
- Roadside Equipment (RSE) – The components installed along the roadside, specifically the wireless communications necessary for vehicle to infrastructure (V2I).

- Network Subsystem – The backhaul or network necessary to connect roadside devices to one another and to connect roadside devices to the various central processing locations.

4.4.2.3 VII Michigan Test Bed Program

The VII Michigan Test Bed Program will provide opportunities for MDOT, industry, and academia to test a range of products and technologies associated with the technical feasibility related to:

- Intelligent vehicles collecting data;
- Intelligent vehicles communicating the collected data to infrastructure; and
- Intelligent vehicles receiving data.

In addition, the VII Michigan Test Bed Program will:

- Archive collected data for the purpose of allowing stakeholders to research and develop the means to fuse, package, and disseminate information to other users (e.g., independent service providers, telematics, etc.) and infrastructure (e.g., CCTV cameras, DMSs, etc.) in support of their agency or organization's goals and objectives; and
- Develop a scaleable approach that allows for other stakeholder participation and the creation of additional test beds.

In short, the VII Michigan Test Bed Program will provide a real-world laboratory to test a range of products and technologies and foster the development of new technologies and applications. The testing phases include an evaluation of the subsystems, applications, and proving the concept of VII in a real-world testing environment. The long-term vision of the test bed is to evaluate full use cases for VII that require either advanced technologies or a higher level of saturation of VII-enabled vehicles in the vehicle fleet.

VII Michigan is intended as a complementary program to efforts in California, Minnesota, and Florida, along with international efforts in Ontario, Canada and Wales, United Kingdom; it is aimed at providing an incubator for testing of a variety of on-board and roadside elements and applications. One primary goal of the program is the sharing of findings and experiences with others in order to further the full realm of VII research and development. The lessons learned as part of the VII Michigan program are intended to feed into the forthcoming formal Field Operational Tests (FOT) being proposed by USDOT.

4.4.3 Permanent Traffic Recorders

One of the responsibilities of MDOT is to record and monitor the levels of vehicle traffic on its highway system. The FHWA mandates that traffic volume counts be taken on a regular basis and that the department estimates what the annual average daily traffic (AADT) is on this system. To accomplish this, MDOT takes a series of short-term counts, typically for a period of 48 hours. These counts need to be adjusted to reflect seasonal and day-of-week variances. To create the adjustment factors to apply to the short-term counts, traffic count data for a whole year is needed. This data comes from PTRs.

Michigan maintains a system of 135 PTR sites installed on freeways, rural highways, and city streets scattered throughout the state. Each site has sensors installed in the pavement, which count vehicles on a continuous basis. The collected data is stored on a traffic counter at the site and the data is downloaded to a central location every day. The download is accomplished by having a computer call and connect to each site, then transfer the data electronically to the central office.

The PTR system has varying levels of technology. While all sites collect vehicle traffic volumes on all traveled lanes, about 90 locations have enhanced equipment that registers vehicle speed data. Additionally, about 42 of these 90 locations are equipped with more sophisticated equipment, which allows them to discriminate between 13 different vehicle types, called vehicle classification; about 39 of those locations can also record the axle weight of trucks while they are in motion.

MDOT has been installing and maintaining PTRs since the mid-1930s. The original equipment tallied vehicle totals every hour on printed paper. Staff had to drive to the locations, typically once per week, to retrieve the rolls of paper and reset the tallies. Vehicle volumes were all that was collected. Over the course of time, the sophistication of data collection devices and communications technologies improved. In the late 1960s, computerization and automatic polling were gaining a foothold making the installation of more locations feasible. Technology continued to improve throughout the 1980s so vehicle classification was possible and high-speed WIM data collection started to become reality. Now these are the norm, yet technology continues to allow us to obtain improvements in accuracy and the way data is collected and retrieved.

4.4.4 Weigh-in-Motion

Starting in the mid-1990s with the onset of changes in traffic collection technologies, MDOT became a participant in the national Strategic Highway Research Project (SHRP), which was a project to gain a better understanding of the impact truck traffic has on the condition and life expectancy of pavement. This participation involved the installation of high-speed WIM sensors in the pavement. The study name was later changed to Long-Term Pavement Performance Study (LTPP), but the goals remained the same.

Keeping with the intent of the study, the WIM sensors were originally installed on roads of varying pavement types and traffic volumes to provide a good cross-section of data to analyze. These locations were randomly selected by the SHRP and then later, the LTPP committee. MDOT started collecting the weight data from these sites and sent the data to the committee.

In 2001, MDOT staff initiated an application to provide greater utility of the information for MDOT and other transportation staff to be able to import, review, store, and report the truck weight data. This application is called Truck Weight Information System (TWIS). In parallel to this TWIS application, MDOT began an effort to expand the WIM system, which dovetailed the expanded system, and its data, in with the TWIS application, providing increased system analysis capabilities along with additional vehicle records.

There are several types of WIM sensors used to detect the vehicles. Over last 10 years, the equipment used to sense the weights has evolved and improved the quality of the recorded weights and vehicle types. The three types that MDOT currently uses are bending plates, piezo sensors, and quartz piezo sensors:

- The bending plate sensor is a large heavy platform suspended on pads and secured to the pavement. This sensor is placed in a wide and deep-cut section of the pavement to set the frame for the system. This system is very accurate but requires regular maintenance.
- The piezo sensor is a strip sensor that is imbedded in a 2-inch wide by 1 1/2-inch deep groove in the pavement and is held in place by epoxy. This sensor interprets the change in pressure exerted on the sensor into an axle weight. This is not as accurate as the bending plate.
- The newest sensor being installed in new and upgraded sites is a quartz piezo sensor. The installation is the same as the piezo, but the material used is equally accurate and more stable than the bending plate sensor.

As the sensor technology improved, another issue related to the collection of accurate weight information became a factor, namely the sensor placement and road surface quality. The factors influencing the axle weight measurement include: bouncing axles (even very slight), road roughness, whether a truck is changing lanes, accelerating or decelerating, and the load distribution. To ensure accurate axle weight measurements, MDOT installs sensors in smooth pavement and performs calibration procedures. Calibration procedures provide the necessary adjustments to the sensor and recording devices to provide a recorded confidence level in the data being collected.

Two important uses of the WIM data are for weight enforcement and pavement design. Reports produced by TWIS allow MSP/MCD officers to review when trucks that may be overweight are on the road so officers can target times to be patrolling the roadways. MDOT and MSP/MCD are installing wireless transmitters at some WIM sites and receivers in patrol vehicles allowing officers to monitor truck weights in real time and use as screening devices to target overweight trucks. This is an important tool to help protect our infrastructure.

MDOT pavement design engineers can also use the TWIS system reports to assure that new pavement is being designed to handle the truck traffic load. To properly design pavement to meet expectations, it is important to have accurate truck volume and weight information. The WIM system will help MDOT design roads to meet existing and anticipated use while not overbuilding or under-sizing the requirements, allowing MDOT to wisely spend precious resources. The WIM system is a newer tool that is continually evolving into an important asset for improving and maintaining MDOT's roadway system for the future.

Chapter 5. Issues and Special Considerations

In this section, other related studies and issues with potential relevance to Michigan highways, bridges, and non-pavement infrastructure programs will be referenced and synthesized. This will include a discussion of pavement condition customer descriptors efforts, truck weights issues, which are further described in the *Freight Profile Technical Report*, and an overview of relevant test studies such as European design pavements.

5.1 Highway Pavement Issues and Related Studies

5.1.1 MDOT System Descriptors - Customer Group Study

MDOT is interested in knowing the public's perception of the state trunkline system and to obtain some general sense of whether MDOT's customers agree with the objective of reaching the 95/85 percent good condition pavement goal based on the performance measure, RSL. In 2005, MDOT, under the direction of leadership and the Pavement Condition Customer Descriptor Team, contracted with PSC to undertake a customer group study to research and determine:

- What characteristics customers believe constitute a road in good, fair, and poor condition;
- What components of MDOT trunkline are most important to customers, such as road smoothness, appearance/cleanliness, visibility, safety features, pavement surface condition, traffic flow, pavement markings, signs, and pavement longevity, and why such components are important; and
- How customer ratings of the conditions correlate with the ratings MDOT uses.

5.1.1.1 Ride-Along Questionnaire

A questionnaire was designed by PSC in consultation with MDOT and participants were recruited to take part in a ride-along of various routes. The questionnaire provided customers with an opportunity to discuss their opinions of the road conditions and rate specific sections of road through a ride-along activity. There were three parts to the survey:

- Introduction/Pre-ride Questions;
- The Ride-Along; and
- Post-Ride Questions.

5.1.1.1.1 Introduction/pre-ride Questions

The participants were provided an overview of the ride-along and attempted to get an overview of the participants' daily driving routine, in addition to obtaining their opinions about the roads in their neighborhood, city/township, and metropolitan area. They were also asked where they believe the best and worst roads are in Michigan and why.

5.1.1.1.2 The Ride-Along

The participants were asked to complete a checklist for various road segments. The participants rated the road's smoothness, cleanliness, pavement appearance, visibility, traffic flow, and pavement markings and signs. They were also asked how often they traveled each section of road and how that section compared to most roads in their area. The ride-along focused on two locations in the Lansing area, both urban and rural trunkline routes, and two locations in the Detroit Metropolitan area. A total of 31 people participated in the focus groups: 16 in the Lansing focus group and 15 in the Detroit focus group. In each location participants were divided into two groups; therefore, four different ride-along groups were surveyed.

5.1.1.1.3 The Post-Ride Questions

These were follow-up questions to elicit details of the participants' opinions of the routes they traveled.

5.1.1.2 Results/Observations from the Customer Group Survey

Overall findings from the ride-along questionnaire are summarized below:

5.1.1.2.1 What Makes a Good Road?

All participants were asked to identify what makes a good quality road. Most cited safety as a primary concern. They specifically indicated that safety includes good traffic flow, easy and safe merges, and the presence of good signs. Smoothness, good visibility, and roads and highways without concrete walls were other qualities mentioned by many participants as comprising a good road.

Smoothness of the road was defined by the participants as the absence of potholes and not having train tracks set into the pavement. Surfacing the road with asphalt rather than concrete was considered to enhance quietness. Also, participants prefer visible lines with wide shoulders and median turn lanes.

5.1.1.2.2 Prioritizing the Importance of Road Qualities

Participants were asked to prioritize six characteristics associated with road quality:

- Smoothness;
- Cleanliness;
- Pavement appearance;
- Visibility;
- Traffic flow; and
- Pavement markings and signs.

They were asked to rank these characteristics for everyday driving, and also to prioritize them for rush hour and night driving.

Traffic Flow

Traffic flow was ranked the most important quality overall for everyday driving as well as rush hour driving. Three of the four groups ranked traffic flow as the most important quality. Traffic flow was ranked the third most important quality for night driving.

Visibility

Visibility ranked fairly high overall for everyday driving. Three of the four groups ranked this characteristic second. Visibility ranked second overall for rush hour as well. Visibility is the most important quality for participants overall when they are driving at night.

Smoothness

Overall smoothness ranked third for everyday driving. For rush hour driving, smoothness was ranked fourth overall. Smoothness is also the fourth most important quality overall for participants when driving at night.

Pavement Markings and Signs

Pavement markings and signs ranked as the fourth most important quality by participants overall for everyday driving. This characteristic ranked third overall for rush hour driving, and it ranked as the second most important quality overall for night driving.

Pavement Appearance and Cleanliness

Participants ranked pavement appearance and cleanliness as the least important qualities for everyday, rush hour, and night driving.

5.1.1.2.3 Correlation with MDOT Ratings of Smoothness

MDOT was particularly interested in learning if there was any correlation between customers' opinions of the road and MDOT's ratings of the roads. The results of the survey indicated that a likely correlation exists between the MDOT International Roughness Index (IRI) rating and customer smoothness rating. The sections that MDOT rated as good on the IRI scale were generally rated good to excellent by the group participants. There were some exceptions within various segments of the ride-along groups where MDOT rated the segment as good and the participants rated it as fair, and vice versa. There were also exceptions where MDOT rated a section as poor and the average participant rating was good. However, for most of the ride-along sections the ratings were close enough to show that MDOT and customers rate the smoothness of roads similarly.

5.1.1.3 Future Customer Group Surveys

The FY 2005 effort was the first step in determining public perception of MDOT's effort in improving the condition of the state trunkline system. MDOT leadership has given direction to build upon the FY 2005 effort and pursue additional customer group surveys.

In the spring of 2006, as part of the *MI Transportation Plan* development, MDOT conducted a follow-up study of driver perceptions of roadway characteristics. More specifically, the study was intended to reveal:

- What characteristics customers believe constitute a road in good, fair, and poor condition.
- What components of MDOT trunklines are most important to customers and why: road smoothness, appearance/cleanliness, visibility, safety features, pavement surface condition, traffic flow, pavement markings and signs, and pavement longevity.
- How customer ratings of the conditions correlate with the ratings MDOT uses.

In addition, MDOT was interested in determining whether there are significant differences between commercial and non-commercial customers with respect to these questions.

Sixty-four drivers were recruited to participate, which provided data about driver perceptions of roadway characteristics under controlled circumstances that allow direct comparison with MDOT ratings.

5.1.1.3.1 Methodology

MDOT specified four highway test routes, each consisting of about 40 miles of roadway over which MDOT has jurisdiction. Two routes are located in the Metropolitan Detroit area, one is in Grand Rapids, and one is in the eastern Upper Peninsula between Kincheloe and Newberry. Each route was subdivided into eight to 10 segments, such that the roadway characteristics of interest are relatively homogeneous within a segment. Thus, the unit of analysis is a specific segment within a specific route. In all, 36 roadway segments were studied.

Participants for the study were recruited from among the population of Michigan residents age 18 or older. Of the 64 drivers that took part, 11 were commercial drivers and 53 non-commercial drivers. Commercial drivers drove over the test routes in commercial trucks they supplied. The commercial vehicle fleet consisted of tractor-trailer rigs, tractors without trailers, and heavy dump trucks. A partner rode with each commercial driver to follow the route, keep track of the segments, and record ratings and comments. Non-commercial drivers were driven over their routes in leased vehicles (mid-size sedans and minivans) by chauffeurs, three to a vehicle.

5.1.1.3.2 Summary Findings

The study suggested that drivers in the aggregate regard safety, smoothness, and pavement condition as the most important characteristics of a roadway. Appearance, cleanliness, and RSL are the least important characteristics. There are no significant differences between commercial and non-commercial drivers with respect to the most important characteristics, though some differences exist where other characteristics are concerned.

The study showed that not all drivers desire the same things in a roadway. Four driver groups can be identified on the basis of what they value most. "Balanced drivers," who accounted for a little more than half of the total, placed roughly equal importance on all eight roadway characteristics studied. "Comfort-conscious drivers," about a third of the total, valued smoothness and pavement condition over everything else. "Navigationconscious drivers," who made up less than 10 percent of the total, valued visibility, pavement markings and signs, and traffic flow over everything else. A fourth group, "safety-conscious drivers," valued safety to the exclusion of everything else; they accounted for less than 10 percent of drivers overall.

Although it is possible to distinguish the eight roadway characteristics in principle, the study showed, in practice, there are strong associations among them. In the participants' subjective ratings, each of the eight characteristics studied were positively correlated with the other seven. In half of these pairs of characteristics, the correlation could be described as large or very large. This overlap in the conception of roadway characteristics was also noted during discussions with the participants, many of whom defined smoothness as a lack of potholes, for example, though potholes are an aspect of surface condition.

The study found a strong correlation between drivers' assessments of pavement condition and the MDOT rating known as Surface Condition. It found weak correlations between drivers' assessments of pavement condition and Pavement Surface Evaluation Rating, drivers' assessments of markings and signs and the date of sign updates, and drivers' estimates of time before major repair work is needed and RSL. It found no correlation between drivers' assessments of smoothness and the IRI, drivers' assessments of pavement condition and the DI, drivers' assessments of traffic flow and LOS, or drivers' assessments of safety and the number of vehicle crashes.

5.1.2 European Design Pavements[11]

The pavement design was described as European because it assimilated features from designs used in Germany, Austria, and Belgium. Interest in using a European pavement design was an outgrowth of a 1992 FHWA scanning tour study of European concrete pavements. The I-75 demonstration project was constructed in conjunction with the 1993 national convention of AASHTO.

A test section using a European pavement design was conducted as part of a 1993 reconstruction project of I-75 in downtown Detroit. The total project involved the reconstruction of 2.3 miles of I-75 (Chrysler Freeway) between I-375 and I-94 (Edsel Ford Freeway). The European pavement design was used for approximately one mile of the northbound section, from the Warren Avenue exit ramp northerly to Piquette Avenue. The remaining portion of the northbound section (from Piquette to I-375) was constructed using a standard 1993 MDOT pavement design. As a result, approximately one mile of test pavement could be directly compared with approximately one mile of a standard pavement design.

MDOT identified the following major differences between the two designs:

The European pavement demonstration project structural section consisted of:

- Ten inches of two-layer concrete pavement with a special exposed aggregate surface texture;

[11] *Memorandum to House Appropriations Subcommittee on Transportation* from William E. Hamilton on May 2, 2005

- Doweled transverse joints at 15-foot spacing;
- Six-inch lean concrete base with six-inch under drains; and
- Sixteen inches of aggregate sub-base placed on an existing prepared sub-grade.

The typical 1993 MDOT section consisted of:

- Eleven inches of single layer concrete pavement with standard surface texture (transverse tinning into the plastic concrete);
- Doweled transverse joints at 41-foot spacing;
- Four inches of open graded drainage course with six-inch under drains; and
- Twelve inches of sand sub-base placed on existing prepared sub-grade.

Note that there are a number of elements in pavement design including but not limited to: type of materials used, pavement thickness, sub-base, placement of joints, drainage, and construction process. One of the unique elements in the I-75 European test design was the use of a two-lift pavement construction method. This process involves placing two layers of concrete pavement, one over another, while the base pavement is still wet. The finished top layer of pavement, the wearing surface, is made from a special concrete mix incorporating an extra hard aggregate. This hard aggregate is left exposed in the finished pavement surface.

The department indicates that the cost of constructing the test section was $87.76 per square yard; the cost of the standard section was $37.58 per square yard. The department believes the two-lift method was the primary reason the contractor bid costs for constructing the test section were significantly higher than for the standard design section. To place two concrete mixes wet on wet, the contractor had to set up two paving plants and use two paving crews, resulting in additional labor and equipment costs. The department believes that other elements affecting the cost of the test section included the use of an enhanced base and premium quality joint seals.

MDOT has monitored the performance of the test and control sections. The last formal study appears to be a report prepared by Michigan State University under contract with the department. The report, dated May 2000, was titled *Cost Effectiveness of European Pavement Demonstration Project: I-75 Detroit*. The report found that neither the test section nor the control section showed enough pavement distress to estimate the RSL. In other words, after seven years, neither section showed distress trends that would allow the researchers to predict how long either section would last. The department continues to make visual surveys of the sections and has found that both sections show little material or structural distress. There is currently no evidence from the I-75 study to indicate that the European pavement test design as used on I-75 is worth the additional construction costs.

Discussions of the I-75 European pavement demonstration project often suggest that the department does not routinely use the European pavement design simply because of the higher construction costs. However, it is important to keep in mind that the department has already incorporated cost-effective elements from innovative pavement designs, including European pavement designs, in current design specifications. One of those elements is the use of a Jointed

Plain Concrete Pavement (JPCP) design. Other pavement design elements incorporated by the department since 1993 include the use of a deeper sub-base, the use of higher quality concrete mix, and the use of higher quality aggregates with better freeze/thaw durability.

The I-75 pavement demonstration project is just one of many studies of pavement performance conducted cooperatively by a number of organizations including the FHWA, AASHTO, construction industry trade groups, engineering schools, and the Transportation Research Board, a part of the National Academy of Sciences. The department works with these groups in an effort to improve pavement design and long-term pavement performance.

5.1.3 Funding Issue

After a few years of maintaining an excellent condition, it is projected that the Michigan trunkline system will experience a period of decline, unless additional resources are allocated to sustain the progress that has been made. Without a sustained increase in funding, the condition will not be able to be maintained into the future.

Some of the underlying factors contributing to this trend are the significantly increased project costs, the need to address expensive large urban renovation projects, increased non-pavement infrastructure needs, and a significant backlog of smaller urban reconstruction. In addition, buying power for capital improvements is reduced over time due to inflationary pressures. To address these significant needs, MDOT will require additional funding or a reallocation of resources, as well as innovative partnering with MDOT stakeholders to maintain the system into the future without losing the headway that has been gained.

Increased funding is needed to continue achieving and sustaining the department's pavement goals. More in-depth analysis will be addressed in the *Investment and Gap Analysis.*

5.2 Highway Bridge Issues and Related Studies

5.2.1 FHWA's Bridge Sufficiency Rating Formula and Bridge Decks

There is an inadequacy within FHWA's bridge sufficiency ratings as it relates to badly-needed work on bridge decks. The condition of the bridge deck is the number one overarching need indicator that drives bridge projects. The bridge deck is a very important structural component of a bridge, since it transfers highway loads to the superstructure, it provides support to the bridge rails, and it often provides strength to the superstructure by way of composite action. The condition of the bridge deck is an important safety consideration, since pot holes on the deck surface can be a traffic hazard, and loose concrete from deteriorated decks can fall on traffic beneath the bridge. Left unattended, a poor bridge deck accelerates the deterioration of the other bridge elements by allowing salt contaminated moisture to penetrate the deck and run onto the elements below.

The sufficiency rating formula within FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* gives very little weight to the condition of a bridge deck. If only the bridge deck is rated in poor condition, the sufficiency rating will not be lowered below 80 points, thus making the bridge ineligible for Highway Bridge Program (HBP) funds. This is because the formula only lowers the bridge's sufficiency rating three points when the deck condition (NBI Item #58) is four. It only lowers the sufficiency rating five points when the deck condition is three or below. In comparison, the formula lowers the bridge's sufficiency rating 25 points when either the superstructure (NBI Item #59) or the substructure (NBI Item #60) conditions are four. The formula lowers the bridge's sufficiency rating 40 points, and 55 points, when the condition of the superstructure or substructure is three or two, respectively.

As a result, if only a bridge deck is rated poor, the bridge does not qualify for HBP funds. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) now allows states to use HBP funds for systematic preventive maintenance of bridges, and the sufficiency rating formula allows use of HBP funds for rehabilitation and replacement when the superstructure or substructure is in poor condition. The only element and work activity that is not adequately covered by the Highway Bridge Program appears to be bridge decks in poor condition.

5.2.2 Funding Issue

Increased funding is needed to meet the department's freeway bridge goals. More in-depth analysis will be addressed in the *Investment and Gap Analysis Technical Report*.

5.2.3 Bridge Under Clearance Issue

When bridges need rehabilitation or replacement, they must be brought up to current standards. This often requires that MDOT raise the under clearance of the bridge over the roadway below. This can come with great expense, since there is cost to raise the bridge and often even greater cost to raise the approach grades, or lower the roadway below the bridge.

5.2.4 Scour Critical Bridges

MDOT has over 400 bridges crossing rivers that are categorized as scour critical. This means that the foundations of these bridges can be compromised by the rapid flowing water during extreme flood events. Retrofit or replacement of these bridges will come at a large cost. The funding needs for these bridges need to be considered in MDOT's long-term strategic plan.

5.3 Highway Non-Pavement Infrastructure Issues

5.3.1 Carpool Parking Lots Issues

Four issues relating to CPLs are summarized below:

- Enforcement of the prohibition of abandoned vehicles, semi-trucks and trailers, and other non-conforming uses. The CPL program would likely benefit from additional authority and stiffer penalties for such instances described above. These types of uses reduce available capacity for the intended CPL users, and can degrade the quality of lots by degrading surface quality, as in the case of heavy semi-trucks and trailers.

- Clarification in the legal definition of CPLs as highway ROW. This would allow stronger and clearer prohibitions of commercial activity in CPLs, including the sale of used vehicles.
- Creation of a five-year template for funding/planning of the CPL program. The current template is three years and precludes sufficient long-term planning for regions.
- Authority to pay for installation and operation of lighting. Lighting CPLs is an important goal of the program for safety and other reasons. However, current state law only allows MDOT to pay for the installation of lighting, but not its operation. A more sensible policy would allow for the installation and operation of lights at a greater number of CPLs, especially in instances where communities lack the resources or the will to fund operation of lighting.

5.3.2 Rest Area issues

- The Roadside Development Program has made great strides in the past three years with the implementation of this new plan and funding. In order to accomplish program goals and objectives, the Roadside Development Program must be able to continue to meet the increasing demands placed on it and continue to improve those facilities that are much needed and used by the traveling public. It should continue to explore opportunities to reduce infrastructure and still meet system needs. Challenges such as rest area spacing, property acquisition, commercial truck parking, mainline expansion projects, and aesthetics are, and will continue to be, issues faced by the Roadside Development Program. In order to address these challenges, the continuation of existing funding is required to move ahead with a plan that will be best for the department and the citizens of Michigan. In addition, support from the road program must be ready to handle the road paving needs in the rest area facilities.
- While it is important to support the Roadside Development Program, it is also necessary to adequately finance the Roadside Maintenance Program that will maintain the buildings and infrastructure for the life of these new buildings. Further studies need to be completed to develop a preventive maintenance program to identify needs and provide funding levels that are adequate to maintain the buildings, ramps, parking areas, and properties in a condition that meets the overall goals of the department. Further communication and coordination between the various programs in the department will result in development that proceeds in a fashion that will not be detrimental to any department program.

5.3.3 Drainage Issues

While inventory of priority storm water system elements is underway, considerable additional work will be needed to develop a complete inventory and evaluation of this system. Prioritization of repair and placement needs can then be developed. Inventory and evaluation of roadway drainage system elements not directly related to storm water management is another significant need that MDOT has been unable to address in a comprehensive way. Inventory and evaluation of the drainage system is currently done as part of individual project development. However, as previously noted, much of the drainage system already in place is nearing the end of its design life. The focus on new project development limits the ability to assess components that may be in need of repair or placement.

5.3.4 Weigh Stations

Weigh Stations are expensive to build (approximately $5 million each) and maintain (static scales are approximately $250,000, every ten or so years; ramp WIM approximately $100,000, every five or six years; ramp and parking lot improvements). Project development has been a problem for MDOT over the years because of greater unmet needs elsewhere.

Emerging technology, such as virtual weigh stations," and mining performance data from the TWIS are proving considerably more efficient and effective than traditional weigh stations in many locations.

5.3.5 Non-Motorized Facilities

- Incorporation of non-motorized uses in the design and construction of new roads or reconstruction:

  MDOT has not always included the provision of non-motorized facilities such as bike lanes, paved shoulders, or sidewalks in the design, construction, or reconstruction of road facilities. As a result, the existing transportation system has some significant multi-modal disconnects. By developing non-motorized facilities based on an accepted non-motorized investment plan, and constructing them in conjunction with road construction or reconstruction, MDOT can cost-effectively create a more efficient network of non-motorized facilities that are safe and secure to travel on.

- Tracking the development and maintenance needs of MDOT maintained on-road and off-road facilities such as wide curb lanes and wide paved shoulders:

  An accurate inventory of the on-road and off-road facilities and their condition is essential to developing a safe network of non-motorized facilities across Michigan. Without the ability to track development and maintenance needs, it is difficult to identify and address system gaps and safety issues.

- Counting the number and types of bicycle and pedestrian users of the non-motorized network:

  Understanding the value and level of use of a non-motorized facility is easier to assess when quantitative data are readily available. A great deal of work has been done in this arena nationally, and MDOT can learn from best practices implemented in other states.

- The development and maintenance of off-road facilities (sidewalks) in MDOT ROW:

  In March of 2006, Public Act 82 was approved by the governor amending Act 51 of 1951. The amendment to Public Act 51 allows eligible road agencies to use their state transportation funds for the construction and improvement of sidewalks.

5.3.6 Type II Noise Abatement Barriers

The most recent State Transportation Commission Noise Abatement Policy (2003) contains no provision for addressing a noise barrier preservation and maintenance. The policy will have to be revisited to address preservation and maintenance needs of existing noise barriers.

5.3.7 Snowmobiles

The Superior Region understands the importance of the snowmobile industry to the Upper Peninsula's economy. According to a recent study conducted by MSU, snowmobiling activities contribute nearly $200 million in sales, income, and trip spending and support nearly 2000 jobs, in the Upper Peninsula alone. This equates to 20 percent of the Upper Peninsula's tourism industry. Statewide, snowmobiling consists of two percent of the total tourism industry and supports over 3,500 jobs[12].

- MDOT should continue to support the snowmobiling industry as an alternate source of transportation, and as an economic benefit. Potential planning issues may include:
  - Developing alternative funding sources to help maintain snowmobile crossings along our state trunkline system.
  - Develop a statewide database of all crossings.
  - Establish partnerships between MDOT, local snowmobile clubs, and the MDNR.

Chapter 6. Integration

This section explores the users of Michigan's highway and bridge system, the economic activities supported by the system, and key performance barriers and opportunities facing highway and bridge users in ways consistent with the other technical reports. This view of Highway and Bridge issues from the users' point of view provides input to the *Integration Technical Report.* The content of this section provides the basis for the *Integration Technical Report* to consider how the Highway and Bridge system may serve the same population segments, support the same activities, and face some of he same performance issues as other components of Michigan's transportation system. This section assesses highway system users and performance issues in light of the findings of the *Travel Characteristics*, *Socioeconomic* and *Land Use Technical Reports* of the MI Transportation Plan.

6.1 Highway and Bridge User Segments

To understand the needs of Michigan's highway and bridge users, system users can be organized into "segments." A "segment" is a group of people who use the transportation system in a similar way. Segmentation of users is helpful in system planning because it is possible that some segments using the highway and bridge system may also heavily utilize transit, non-motorized infrastructure or other aspects of the system as well.

[12] *State and Regional Economic Impacts of Snowmobiling in Michigan*, Michigan State University, 1998

The *Travel Characteristics Technical Report* describes in detail the profile of travelers using Michigan's highways and bridges. Key segments of highway and bridge users include:

- Travelers Driving alone on the highway System;
- Travelers driving or participating in carpools on the highway system;
- Transit users taking routes that utilize trunkline facilities;
- Children riding busses to school, and;
- Cyclists and pedestrians who must safely interface with the highway and bridge system.

6.2 Key Highway and Bridge User Activities

These user segments depend on the state's highway system to access many different activities in Michigan's economy. While users of highways and bridges span the full range of trip purposes and trip lengths, some of the activities supported by the system include:

- Pleasure trips by residents and visitors:
  - Pleasure trips are the most common trip purpose for long distance travel in Michigan;
  - Rest areas, which are an important element of non-pavement infrastructure in MDOT's trunkline system, play a key role in the state's tourism industry, as well as the experiences and perceptions of MDOT's customers regarding safety, security, and convenience of travel on the state's highways.
- Commercial vehicle trips, which account for nine percent of vehicle miles on the state trunkline system in 2004. The role of commercial vehicle traffic is critical due to impacts on:
  - The state's economy and potential for business and industrial development; and
  - Pavement life, bridge life, design standards and highway/bridge maintenance requirements.
- Commuters on urban elements of the trunkline system, whether using a SOV (single-occupant vehicle) or a carpool:
  - CPLs are another non-pavement infrastructure element of the trunkline system that play an important role in encouraging the use of carpools, hence reducing congestion and the environmental and economic consequences of congestion.

6.3 Performance Barriers and Opportunities

Transportation system performance barriers related to Michigan's highways and bridges have been documented throughout this Technical Report. Performance opportunities may be realized for Michigan's system users by removing any of these barriers, including:

- **Pavement Deterioration**: MDOT's goal of having 95 percent of pavement in good condition on the freeway system and 85 percent on the non-freeway system by 2007 has led to significant improvements in recent years. However, after a few years of maintaining in excellent condition, it is projected that the Michigan trunkline system will experience a period of decline, unless additional resources are allocated to sustain the progress that has been made. Pavement condition is important to support roadway connections for intermodal freight, transit and other modes as well.

- **Bridge Deterioration**: Due to an inadequacy in FHWA's bridge sufficiency ratings, the Highway Bridge Program appears not to adequately cover bridge decks in poor condition, as discussed in **Section 5.2, Highway Bridge Issues and Related Studies**, of this technical report. If bridges deteriorate, the potential for not only traditional roadway uses, but also for non-motorized, transit and freight uses could stand between system users and activities involving multiple modes.
- **Roadway Congestion:** Roadway congestion interferes with not only travel times, but also with reliability of service. Congested roads can inhibit the on-time performance of intercity and transit services, resulting in mixed connections on the integrated system. Roadway congestion clearly is a barrier between Michigan's integrated system users and their activities of choice.
- **Safety Risk:** While safety risk is explored in-depth in the *Safety Technical Report* of *MI Transportation Plan*, it is important to note that safety risks on roadways may affect pedestrian, transit and freight safety, increasing the costs of doing business in Michigan, and interfering with the state's overall economic performance.
- **Lack of Connectivity:** If connectivity to major activity centers and other modes is compromised, barriers arise between system users and activities. When modernizing and reconstructing roadways, it is especially important to check for the safe connectivity of roadway infrastructure to major transit, aviation, passenger, and freight hubs as well as port facilities.
- **Balance of Pavement and Non-Pavement Needs:** Non-pavement infrastructure such as noise abatement barriers, drainage structures, rest areas, weigh stations and park and ride facilities are important components of Michigan's highway and bridge system. However, their condition and performance is not measured and benchmarked as rigorously or objectively as roadway pavement conditions, capacity and safety. If non-pavement investments do not keep pace with increases in highway system use and modernization, the value of the system may be diminished both for users and as an asset to the state.

6.4 Integrating Highways, Bridges and Non-Pavement Infrastructure

Due to the dominant role of highways and highway bridges in Michigan's transportation system, the state's trunkline system of highways, bridges, and non-pavement infrastructure forms a central and integral part of the state's long-range planning process. The trunkline system bears a direct relationship to all other elements of the transportation long-range plan, as well as many non-transportation plans and aspects of life throughout the state. Some sources of economic vitality in Michigan's economy dependent on pavement and non pavement highway infrastructure include:

- Economic development;
- Tourism;
- Security (evacuation routes);
- Safety (crashes);
- Air quality;
- Emergency services (fire and ambulance); and
- Quality of life for residents.

To support these ends, investments and projects must balance both the pavement and non-pavement aspects of the highway and bridge system. For example, investing in pavement conditions and capacity to support a tourist or recreational corridor must include associated investment in markings, rest areas and other non-pavement amenities to support the quality of the corridor for the recreational purpose.

Non-pavement infrastructure also plays an important role in managing highway safety and capacity needs in ways that may improve other components of Michigan's transportation system. For example, a safety or operational improvement may make a non-pavement investment in a signal, which could support non-motorized use of the system in addition to typical roadway traffic. Furthermore, operational, safety and ITS solutions can provide less expensive "fixes" for areas approaching congestion where pavement expansion is not an option.

The Integration Technical Report further examines different types of investments in pavement and non-pavement investments that can enhance the value of the highway and bridge system as a component of Michigan's overall transportation system.

Providing the highest quality integrated transportation services for economic benefit and improved quality of life

MI Transportation

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